

STATE OF OREGON



# **TASK FORCE ON AUTONOMOUS VEHICLES**

**2019 FINAL REPORT TO THE OREGON STATE LEGISLATURE**

Sept. 12, 2019



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**2019 FINAL REPORT**

**To the Oregon State Legislature  
House Bill 4063 Task Force**

**Sept. 12, 2019**

# TASK FORCE ON AUTONOMOUS VEHICLES

## **Task Force Membership**

Chair Lt. Tim Tannenbaum, Sen. Sara Gelser, Sen. Fred Girod, Rep. Lynn Findley, Rep. Susan McLain, Richard Blackwell, Marie Dodds, Steve Entler, Daniel Fernandez, Chris Hagerbaumer, Eric Hesse, Cheryl Hiemstra, Capt. Stephanie Ingraham, Neil Jackson, Jana Jarvis, Mark MacPherson, Evan Manvel, Galen McGill, David McMorries, Robert Nash, Todd Nell, Jeff Owen, Carly Riter, Eliot Rose, Jeremiah Ross, Paul Savas, Becky Steckler, Graham Trainor, Sean Waters, Caleb Weaver

## **Designated Alternates**

Hanan Alnizami, Mike Bezner, Waylon Buchan, Miriam Chaum, Carlos Contreras, Kristine Cornett, Kate Denison, Jeb Doran, Amanda Howell, Ritchie Huang, Gail Krumenauer, Tom McClellan, Chris Muhs, John Powell, Michael Rose, Jacob Sherman, Aeron Teverbaugh, Young Walgenkim, Caleb Winter, Sara Wright

## **Oregon Department of Transportation Staff**

Jenna Adams-Kalloch (Emerging Technology Policy Lead), Adam Argo (Principal Planner), Maureen Bock (Chief Innovation Officer), Roberto Coto (Innovative Programs Coordinator), Andrew Dick (Connected, Automated and Electric Vehicle Advisor), Paul Duncan (Policy Advisor), Michelle Godfrey (Education and Outreach Coordinator), Kevin Haas (Traffic Standards Engineer), Amy Joyce (Legislative Liaison), Sarah Kelber (Public Information Representative), Ali Lohman (Automated Vehicle Policy Analyst)

## **Disclaimer**

This final report is submitted to the Oregon State Legislature as allowed by House Bill 4063 (2018).

The contents of this report reflect the view of the Task Force on Autonomous Vehicles, which is solely responsible for the facts and accuracy of the materials presented.

## **House Bill 4063 (2018)**

The Task Force on Autonomous Vehicles was established by House Bill 4063 in Oregon's 2018 legislative session. The bill directs the task force to develop recommendations for automated vehicle legislation. In accordance with the bill, the task force submitted a report to the Interim Joint Committee on Transportation on Sept. 11, 2018. The 2018 report included recommendations for legislation to address the following issues: licensing and registration, law enforcement and crash reporting, cybersecurity, and insurance and liability.

HB 4063 also allowed the task force to develop a second report due to the Legislature on Sept. 15, 2019, which may address topics including land use, road and infrastructure design, public transit, workforce changes, and state responsibilities relating to cybersecurity and privacy. On Sept. 10, 2018, the task force voted to pursue the second report. This report fulfills those requirements.

## **Structure of Report**

The report begins with a brief overview of automated vehicle technology and the considerations that prompted the creation of the task force. The next section outlines the task force membership, structure, and process. Then, the report includes materials and recommendations on six topics: 1) vehicle code amendments and public safety; 2) cybersecurity, privacy and data; 3) road and infrastructure design; 4) land use; 5) public transit; and 6) workforce changes. The appendices of the report include the text of HB 4063 (2018), additional comments issued by task force members, and comments from non-members.

## Abbreviations and Acronyms

ADS	Automated driving system
AV	Automated vehicle
CAV	Connected and automated vehicle
CV	Connected vehicle
DSRC	Dedicated short range communications
DUII	Driving under the influence of intoxicants
EV	Electric vehicle
FHWA	Federal Highway Administration
FMVSS	Federal Motor Vehicle Safety Standards
HAV	Highly automated vehicle
HB 4063	House Bill 4063 of 2018
ITE	Institute of Transportation Engineers
MUTCD	Manual on Uniform Traffic Control Devices
NACTO	National Association of City Transportation Officials
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
OBU	On-board unit
ODOT	Oregon Department of Transportation
PKI	Public key infrastructure
RSU	Road-side unit
SAE	International Society of Automotive Engineers
SCMS	Security Credential Management System
US DOT	United States Department of Transportation
V2I	Vehicle-to-infrastructure
V2V	Vehicle-to-vehicle
V2X	Vehicle-to-everything

## Definitions

**Automated driving system (ADS):** The hardware and software that are collectively capable of performing the entire driving task on a sustained basis. This term is used to describe vehicles with SAE automation levels of 3, 4 or 5. (See “Levels of Automation” on page 5.)

**ADS-dedicated vehicle:** A vehicle designed to be operated exclusively by a level 4 or 5 automated driving system for all trips within its given operational design domain limitations (if any). (See “Types of Vehicles” on page 6.)

**Connected vehicle:** A vehicle equipped with communications technology that allows it to exchange messages with other vehicles, infrastructure, or even cell phones. The messages may convey a vehicle’s speed and bearing, warning about upcoming construction zones or crashes on the route, weather alerts, or other information critical to safety and system management.

**Conventional vehicle:** A vehicle designed to be operated by a conventional driver during part or all of every trip. A conventional vehicle may be equipped with automated features, but requires a conventional driver to operate the vehicle during portions of each trip. (See “Types of Vehicles” on page 6.)

**Deployment:** The operation of an automated vehicle on public roads by members of the public who are not employees, contractors, or designees of a manufacturer or for purposes of sale, lease, providing transportation services for a fee, or otherwise making commercially available outside of a testing program.

**Driver assistance technology:** A general term for level 1 and level 2 automation features, which are capable of performing only part of the dynamic driving task and thus require a human driver. Examples of driver assistance technology include lane keeping assistance, lane centering, and adaptive cruise control.

**Dual-mode vehicle:** A type of ADS-equipped vehicle designed for both driverless operation and operation by a conventional driver for complete trips. (See “Types of Vehicles” on page 6.)

**Fallback-ready user:** The user of a vehicle equipped with a Level 3 automated driving system who is able to operate the vehicle and is prepared to respond if the vehicle requests that the user intervene. (See “Levels of Automation” on page 5.)

**Federal Motor Carrier Safety Regulations:** The rules and regulations establishing requirements for the safe operation of commercial motor vehicles, applicable to all employers, employees, and commercial motor vehicles that transport property or passengers in interstate commerce. Federal Motor Carrier Safety Regulations are issued by the Federal Motor Carrier Safety Administration.

**Federal Motor Vehicle Safety Standards (FMVSS):** The standards and regulations establishing the minimum safety performance requirements to which manufacturers of motor vehicles and items of motor vehicle equipment must conform and certify compliance. FMVSS are issued by the National Highway Traffic Safety Administration.

**Highly automated vehicle (HAV):** A vehicle equipped with automated technology capable of performing the entire driving task, including operating the vehicle and monitoring the driving environment, for at least part of a trip. This term is used to describe vehicles with SAE automation levels of 3, 4 or 5. (See “Levels of Automation” on page 5.)

**Operational design domain:** The environment and specific conditions for which an automated vehicle is engineered and in which it can safely operate.

**Testing:** The operation of an automated vehicle on public roads by employees, contractors, or designees of a manufacturer for the purpose of assessing, demonstrating, and validating the autonomous technology’s capabilities.

**Vehicle-to-everything communications:** Exchange of messages between a connected vehicle and any or all elements of the driving environment, including other vehicles, roadside infrastructure, or even cellphones. This is sometimes referred to as V2X communication.

**Vehicle-to-infrastructure communications:** Exchange of messages between a connected vehicle and connected infrastructure, often through roadside units. This is sometimes referred to as V2I communication.

**Vehicle-to-vehicle communications:** Exchange of messages between two or more connected vehicles, which is sometimes referred to as V2V communication.

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# EXECUTIVE SUMMARY

## **House Bill 4063 (2018)**

The Task Force on Autonomous Vehicles was established by House Bill 4063 in Oregon's 2018 legislative session. In 2018, the task force submitted a mandatory report to the Legislature with recommendations for a permitting process to allow testing of automated vehicles on public roads. House Bill 4063 also allowed the task force to pursue a second, optional report to address "the potential long-term effects of autonomous vehicle deployment," including land use, road and infrastructure design, public transit, workforce changes, and state responsibilities relating to cybersecurity and privacy. This report fulfills those requirements. Both reports can be found online at the website for the Task Force on Autonomous Vehicles.<sup>1</sup>

## **Ongoing Development of Automated Vehicle Technology and Policies**

Because automated vehicle technology is still in development, the long-term effects of automated vehicle deployment remain uncertain. The task force based its work on the best information currently available, but recognizes that the potential impacts and recommended best practices may change as the technology continues to advance. Much of the material prepared by the task force is informational and is intended to provide the Legislature with a status update on our present understanding of automated vehicle impacts and the current state of practice. The task force also makes recommendations for steps Oregon could take now to prepare for the deployment of automated vehicles and align automated vehicle policy with existing state goals.

## **Task Force Materials and Recommendations**

The task force has prepared materials and recommendations on six topics related to automated vehicles: (1) vehicle code amendments and public safety; (2) cybersecurity, privacy and data; (3) road and infrastructure design; (4) land use; (5) public transit; and (6) workforce changes. The task force work was informed by national guidance, studies and recommendations by national organizations and research institutions, best practices in other jurisdictions, and presentations by experts.

## **Vehicle Code Amendments and Public Safety**

This report includes three statements of intent related to vehicle code amendments and public safety. The first statement of intent addresses how to incorporate automated vehicles into Oregon's existing vehicle code without undermining existing definitions for conventional vehicles. The second suggests that when creating new terms and definitions related to automated vehicles, Oregon should look to the International Society of Automotive Engineers for concepts. The third acknowledges that minimum insurance coverage may need to change in the future to address certain types and uses of automated vehicles.

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<sup>1</sup> Oregon Department of Transportation. 2019. "Task Force on Autonomous Vehicles." Available at: <https://www.oregon.gov/ODOT/Get-Involved/Pages/Task-Force-on-Autonomous-Vehicles.aspx>

## **Road and Infrastructure Design**

This report includes a summary of national guidance on automated and connected vehicle infrastructure, as well as an overview of various state automated and connected vehicle infrastructure projects. It also includes twelve impact assessments, each of which examines an infrastructure element that may need to change for, or may be changed in response to, automated vehicle deployment. The impact assessments cover a broad range of topics: road markings, road signs, traffic signals, work zones and school zones, vehicle-to-infrastructure communications and cybersecurity, curb space management, parking, lane widths, and electric vehicle charging infrastructure. Some of these infrastructure elements may be vital to ensuring the safe operation of automated vehicles, while others could enhance the potential benefits of automated vehicles.

The impact assessments consider if and when Oregon may need to make these changes. The assessments also outline the best information currently available about potential co-benefits, barriers, impacts to infrastructure owner/operators, and relevant national guidance and key decision makers for each infrastructure topic. Finally, the assessments identify next steps Oregon could take to prepare the state's transportation infrastructure for automated vehicles.

## **Cybersecurity, Privacy and Data**

This report provides information on cybersecurity and privacy considerations related to automated vehicles. It acknowledges the federal and state roles in regulating vehicle cybersecurity. It also discusses privacy concerns raised by automated vehicles, such as issues with geolocation data, and potential mitigation strategies, including concepts such as the "right to be forgotten."

The task force acknowledges that these privacy issues are not unique to automated vehicles and apply to many different connected devices. Other deliberative bodies are considering policy changes to address privacy more holistically, and automated vehicles should be part of those discussions.

## **Land Use**

This report outlines how other jurisdictions are preparing for the potential impacts of automated vehicles, looking specifically at data management, land use planning, greenhouse gas reduction, and pricing strategies. This report also provides information on occupancy pricing and how it could potentially apply to automated vehicles. Finally, the task force recommends the state's automated vehicle work further Oregon's existing goals, including goals for transportation, safety, land use planning, economic development, and equity.

## **Public Transit**

This report summarizes several pilot projects and demonstrations that combine public transit and automated vehicle technologies. It also provides recommendations for how to use automated vehicle technology to enhance and preserve public transit, as well as recommendations for utilizing automated vehicle technology to improve safety and access to transit. To help policymakers consider how automated vehicles could impact different components of the public transit system in Oregon, the report includes a matrix of all the different components and briefly notes how public transit could incorporate different levels of automation.

## **Workforce Changes**

On behalf of the task force, Oregon Employment Department staff conducted a workforce analysis that identifies primary and secondary occupations, comprising approximately five percent of Oregon's workforce, which could be affected by automated vehicle deployment. The analysis also includes projected employment changes for those occupations and estimates the potential job effects of mainstream automated vehicle adoption.

This report recommends the Legislature authorize and fund an independent workforce study and recommends elements to be included in this broader, more comprehensive workforce study. The recommendations call for a quantitative analysis and identification of potential policy interventions. These recommendations build on an earlier recommendation made by the Task Force on Autonomous Vehicles in 2018 to conduct an independent workforce study.

Chair Tannenbaum addresses the Task Force on Autonomous Vehicles at the Dec. 4th meeting.



# INTRODUCTION TO AUTOMATED VEHICLES

The following section provides background information on different levels of vehicle automation and types of vehicles. It also outlines the division of federal and state responsibilities with respect to regulation of automated vehicles, as well as giving an overview of some developments in automated vehicle testing and policy specific to Oregon. This information aligns with “AV 101” materials presented to the task force in preparation for the 2018 report, as well as updates provided in preparation for the 2019 report. These materials, and other background materials that served as a basis for task force discussion, are available on the ODOT task force website.<sup>2</sup>

## Levels of Automation

The Society of Automotive Engineers (SAE) has designated six levels of automation from Level 0 to Level 5 to distinguish automated systems with different capabilities.<sup>3</sup> Figure 1 illustrates the six levels of automation, which are also described in simplified form below.

### Level 0: No Automation

The vehicle is not equipped with driving automation. The driver performs the entire driving task, including monitoring the driving environment.

### Level 1: Driver Assistance

The vehicle is equipped with a system that automates either accelerator/brake functions (e.g., adaptive cruise control) or steering (e.g., lane-keeping assist). The driver performs all other aspects of the driving task, including monitoring the driving environment. The driver supervises the automated system and intervenes as necessary to maintain safe operation of the vehicle.

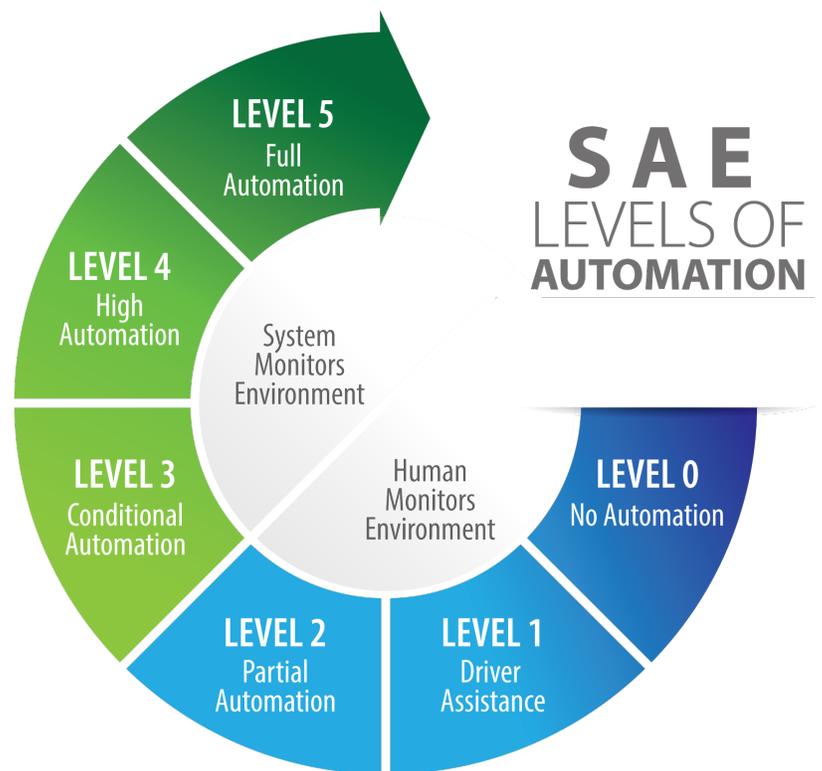


Figure 1: SAE Levels of Automation

2 Available at: <https://www.oregon.gov/ODOT/Get-Involved/Pages/Task-Force-on-Autonomous-Vehicles.aspx>

3 Society of Automotive Engineers. 2018. "Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles." Available at: [https://www.sae.org/standards/content/j3016\\_201806/](https://www.sae.org/standards/content/j3016_201806/)

## Level 2: Partial Automation

The vehicle is equipped with a system that automates both accelerator/brake functions and steering. The driver performs all other aspects of the driving task, including monitoring the driving environment. The driver supervises the automated system and intervenes as necessary to maintain safe operation of the vehicle.

## Level 3: Conditional Automation

The Automated Driving System (ADS) is capable of performing the entire driving task, including monitoring the driving environment, under certain circumstances (e.g., only on a limited access highway, but not on city streets; only in clear weather, but not in heavy precipitation; etc.). While the vehicle is within the environment for which the ADS is engineered to operate (the "operational design domain"), an individual sitting in the driver's seat is not required to supervise the automated system or intervene to maintain its safe operation. However, that individual must act as a "fallback-ready user," who is able to assume manual control of the vehicle if it exceeds the limits of its operational design domain.

## Level 4: High Automation

The ADS is capable of performing the entire driving task, including monitoring the driving environment, and without the need for a fallback-ready user. Level 4 vehicles are still confined to a certain operational design domain (e.g., a vehicle that can carry passengers within a metropolitan area, but not outside its boundaries, due to its ADS relying on high-resolution maps it only possesses for that area). At this level, a vehicle may not have manual controls, such as a steering wheel and accelerator/brake pedals, and may exclusively carry passengers without ever having a "driver." However, a level 4 vehicle may also have manual controls, and allow a human driver to operate the vehicle conventionally when the ADS is disengaged.

## Level 5: Full Automation

The ADS is capable of performing the entire driving task, including monitoring the driving environment, and without the need for a fallback-ready user, under any conditions a human driver could reasonably navigate. Level 5 vehicles are not confined to an operational design domain, and have driving capabilities equivalent to those of a human driver. At this level, a vehicle may not have manual controls, and may exclusively carry passengers without ever having a driver. However, a level 5 vehicle may also have manual controls, and allow a human driver to operate the vehicle conventionally when the ADS is disengaged.

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# Types of Vehicles

In 2018, SAE updated its taxonomy and definitions for automated vehicles. Included in the revision were new definitions for three types of vehicles: conventional vehicles, ADS-dedicated vehicles, and dual-mode vehicles.

**Conventional vehicle:** A vehicle designed to be operated by a conventional (human) driver during part or all of every trip. A conventional vehicle may be equipped with automated features, but requires a conventional driver to operate the vehicle during portions of each trip.

**ADS-dedicated vehicle:** A vehicle designed to be operated exclusively by a level 4 or 5 automated driving system for all trips within its given operational design domain limitations (if any).

**Dual-mode vehicle:** A type of ADS-equipped vehicle designed for both driverless operation and operation by a conventional driver for complete trips.

In the future, a mix of automated vehicles and vehicles with no automation will operate on our roads. Even within levels of automation, there will likely be variations in the capabilities of different vehicles. For example, a level 4 automated vehicle may be 1) a conventional vehicle if it requires a conventional driver for part of a trip, 2) an ADS-dedicated vehicle if it is operated solely by an automated driving system and has no brakes or pedals for a conventional driver, or 3) a dual mode vehicle if either a conventional driver or an automated driving system could operate the vehicle for the entirety of a trip. The future transportation system will need to accommodate vehicles with a wide range of automated features and capabilities, in addition to vehicles with no automated technology at all.

State laws will also have to accommodate vehicles with varying levels of automation. In vehicles with no automation, humans bear responsibility for driving safely, following the rules of the road, maintaining insurance coverage, and other duties such as exchanging information and filing appropriate reports in the event of a crash. When a level 3 or higher automated vehicle is operating in automated mode, these responsibilities may fall to the manufacturer, the owner, the operating company, or other entities. In some cases, a level 4 or 5 vehicle may travel with no human occupants at all, or may accommodate only human passengers who play no role in the driving task and have no responsibility for vehicle driving behavior.

It's also important to keep in mind that there are many potential applications for automated vehicle technology. Automated passenger vehicles and on-demand fleets frequently make headlines, but there are many kinds of automated vehicles in development, including low-speed shuttles, buses, local delivery vehicles, medium- and long-haul freight trucks, and heavy equipment vehicles. Any changes to policy or to transportation infrastructure will need to consider many types of vehicles equipped with a range of automated technology.

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## **Federal, State and Local Roles in Regulating Automated Vehicles**

The National Highway Traffic Safety Administration (NHTSA) has directed states and local jurisdictions considering legislation for automated vehicles to maintain the current delineation between federal and state regulatory authority. The federal government has authority to regulate motor vehicles and motor vehicle equipment by setting and enforcing safety standards and managing recalls. States regulate human drivers and other aspects of motor vehicle operation, including licensing drivers, registering vehicles, and regulating insurance and liability. Both state and local governments have authority to enact and enforce traffic laws.

According to NHTSA's "Automated Vehicles 3.0: Preparing for the Future of Transportation," US DOT is preparing for automated vehicles by:

- Establishing performance-oriented, consensus-based, and voluntary standards and guidance for vehicle and infrastructure safety, mobility, and operations.
- Conducting targeted research to support the safe integration of automation.
- Identifying and removing regulatory barriers to the safe integration of automated vehicles.
- Ensuring national consistency for travel and interstate commerce.
- Educating the public on the capabilities and limitations of automated vehicles.

NHTSA also suggests that state and local governments prepare for automated vehicles by:

- Reviewing laws and regulations that may create barriers to testing and deploying automated vehicles.
- Adapting policies and procedures, such as licensing and registration, to account for automated vehicles.

- Assessing infrastructure elements, such as road markings and signage, so that they are conducive to the operation of automated vehicles.
- Providing guidance, information, and training to prepare the transportation workforce and the general public.

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## National Overview

As of August 2019, 33 states and the District of Columbia have passed laws relating to automated vehicles, and governors in 11 states have issued executive orders.<sup>4</sup> These laws and executive orders vary widely in scope. Some provide only terms and definitions, others call for studies, and a few have taken the lead in crafting detailed automated vehicle policies. However, the scope of a state's regulations is not necessarily indicative of the scale of its automated vehicle activity. For example, California has detailed laws and regulations relating to automated vehicles, while Florida has relatively brief statutory language, and Arizona has three executive orders. Yet all three states have hosted significant automated vehicle testing.

Testing of highly automated vehicles, those vehicles with SAE automation levels 3 and above, has occurred on public roads in several states, including Arizona, California, Colorado, Florida, Michigan, Nevada, Pennsylvania, Texas, and Washington. In California, 48 companies had permission to conduct on-road testing in 2018 and collectively drove over two million miles in autonomous mode. Testing is also being conducted on closed tracks at universities and research facilities across the United States.

As many as 17 states have established regulations that allow deployment of automated vehicles on public roads, although some states have imposed certain restrictions, for example by limiting deployment to specific locations or types of vehicles. So far, highly automated vehicles have only been deployed within narrow parameters. For example, several jurisdictions have hosted pilot deployments of low-speed automated shuttles. As of July 2019, the California Public Utilities Commission has granted four automated vehicle manufacturers permission to carry passengers, but the companies cannot charge the passengers and must have a human safety driver behind the wheel at all times.<sup>5</sup> Waymo is also piloting a ride-hailing service using automated vehicles in the suburbs of Phoenix, Arizona. As in California, these vehicles have human safety drivers to serve as backup for the automated driving system.<sup>6</sup>

Because automated vehicle technology is still in development and automated vehicles have yet to be deployed at scale, it is still uncertain how automated vehicles will impact a broad range of policy areas. For example, automated vehicle deployment may require changes to road striping practices, but manufacturers may also advance navigation technologies such that automated vehicles can operate safely with no changes to road striping. Some of the potential impacts of automated vehicles will also depend on the success of competing business models. For instance, changes in demographic patterns will likely vary significantly depending on whether automated vehicles are deployed as shared fleets or as personal vehicles. It is also important to note that even when automated vehicles are deployed at scale, the business models and impacts will likely vary from region to region, just as transportation options today are different in metropolitan downtowns, suburbs, and rural areas.

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4 20 states have laws relating to truck platooning, a driver assistance technology in which two or more tractor-trailer vehicles use connected acceleration and braking systems to travel safely at a close distance.

5 Murphy, Mike. MarketWatch. July 2, 2019. "Waymo self-driving cars get greenlight to carry passengers in California." Available at: <https://www.marketwatch.com/story/waymo-self-driving-cars-get-green-light-to-carry-passengers-in-california-2019-07-02>

6 Waymo. 2019. "FAQ – Riding with Waymo One." Available at: <https://waymo.com/faq/>

The timing of wide-scale automated vehicle deployment remains uncertain, with predictions ranging from a couple of years to a couple of decades. Many companies, government bodies, institutions, and universities are researching the potential impacts of automated vehicles, but this research is speculative and may change as the technology develops. For more information about how other jurisdictions are preparing for automated vehicle deployment and for current thinking about how automated vehicles could impact specific policy areas, see the Task Force on Autonomous Vehicles Materials and Recommendations starting on pg. 19.

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## Oregon Automated Vehicle Policy

From 2014 to 2015, the Oregon Department of Transportation (ODOT) conducted an assessment of the impacts that connected and automated vehicles could have on agency operations. ODOT concluded that they could have a disruptive impact across agency divisions and the transportation system as a whole. Automated vehicles technology may necessitate new requirements for signage and striping, while the agency may also need new systems for collecting, processing, and disseminating data to support automated vehicles. ODOT created a Connected and Automated Vehicle Steering Team in 2015 to coordinate agency policy development regarding automated vehicles. The group includes representatives from across ODOT divisions as well as Oregon State Police and the Federal Highway Administration.

In response to early interest in automated vehicles testing, ODOT worked with law enforcement and private-sector partners to develop a voluntary notification process, which was formally established in 2017. To participate in the voluntary notification process, companies notify ODOT of plans to test automated vehicles on public roads. ODOT then notifies Oregon State Police, which coordinates with local police departments along the testing route. ODOT also provides the testing company with information about any scheduled lane closures, maintenance, and other known hazards along the testing route. However, because ODOT does not currently have regulatory authority over automated vehicle testing, manufacturers are not required to notify the state when testing occurs.

House Bill 4063, passed by the Oregon Legislative Assembly during the 2018 session, was the first legislation enacted in the state to address automated vehicles. House Bill 4063 designated ODOT as lead agency for automated vehicle policy in the state, in line with guidance from NHTSA. The bill also established the Task Force on Autonomous Vehicles and directed the task force to develop recommendations for automated vehicle legislation.

In Sept. 2018, the task force submitted a report with recommendations to the Interim Joint Committee on Transportation. The majority of the recommendations centered on a permitting process for testing of automated vehicles in Oregon. The proposed permitting process would collect certain information about vehicles and drivers involved in testing, set minimum insurance coverage requirements for entities testing automated vehicles, require certain safety assurances regarding automated driving systems, and direct testing entities to engage with law enforcement and first responders to promote safe testing. Additionally, the 2018 report makes recommendations for ongoing work of the task force and identifies areas for additional study as automated vehicles approach deployment.<sup>7</sup>

House Bill 4063 also allowed the task force to develop a second report due to the Legislature on Sept. 15, 2019. In this second report, the task force could address “the potential long-term effects of autonomous vehicle deployment,” including land use, road and infrastructure design, public transit, workforce changes, and state responsibilities relating to cybersecurity and privacy. This report addresses those topics.

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<sup>7</sup> The 2018 Report is available at: <https://www.oregon.gov/ODOT/Get-Involved/Documents/AVTF-2018-report-final.pdf>

# TASK FORCE ON AUTONOMOUS VEHICLES

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## Task Force Membership

House Bill 4063 named 31 stakeholder groups to be members of the task force. In accordance with the legislation, four legislators were named by the Senate President and House Speaker, with the remaining 27 members named by ODOT Director Matthew Garrett. These 27 individuals represented specific industries and organizations identified in the bill. At the first task force meeting on April 18, 2018, the members unanimously elected Lt. Tim Tannenbaum of the Washington County Sheriff's Office chair of the Task Force, and Lt. Tannenbaum continued as chair during preparations for the 2019 report.

Four members withdrew from the task force during the second report process. Rep. Denyc Boles served as the Republican member from the House of Representatives until she was appointed to a Senate seat in June. She was later replaced by Rep. Lynn Findley. Capt. Theresa Bloom represented Oregon State Police until she was replaced by Capt. Stephanie Ingraham. Carrie MacLaren represented the Department of Land Conservation and Development and was later replaced by Evan Manvel. Jared Franz represented the Amalgamated Transit Union. In addition, David McMorries originally represented the Office of the State Chief Information Officer at the Department of Administrative Services but later took a new position as the Chief Information Security Officer at Oregon State University. Because he continued to work in the cybersecurity field, he retained his position on the task force. The list below reflects the membership at the time the final report was approved.

**Chair: Lt. Timothy Tannenbaum**

Washington County Sheriff's Office, law enforcement

**Rep. Susan McLain**

Oregon Representative (D)

**Rep. Lynn Findley**

Oregon Representative (R)

**Sen. Sara Gelser**

Oregon Senator (D)

**Sen. Fred Girod**

Oregon Senator (R)

**Richard Blackwell**

Department of Consumer and Business Services

**Marie Dodds**

American Automobile Association

**Steve Entler**

Radio Cab, taxicab industry

**Daniel Fernández**

Jaguar Land Rover, automotive industry

**Chris Hagerbaumer**

Oregon Environmental Council, nonprofit organization

**Eric Hesse**

City of Portland, League of Oregon Cities

**Cheryl Hiemstra**

Department of Justice

**Capt. Stephanie Ingraham**

Oregon State Police

**Neil Jackson**

Oregon Trial Lawyers Association, trial lawyers

**Jana Jarvis**

Oregon Trucking Association

**Mark MacPherson**

Teamsters, transportation union

**Galen McGill**

Department of Transportation

**David McMorries**

Oregon State University, cybersecurity industry

**Evan Manvel**

Department of Land Conservation and Development

**Robert Nash**

State Farm, automotive insurance industry

**Todd Nell**

Office of Workforce Investments

**Jeff Owen**

TriMet, Oregon Transit Association

**Carly Riter**

Intel Corp., AV technology industry

**Eliot Rose**

Metro, metropolitan planning organization

**Jeremiah Ross**

Ross Law LLC, consumer protection advocates

**Paul Savas**

Clackamas County, Association of Oregon Counties

**Becky Steckler**

University of Oregon, public university

**Graham Trainor**

AFL-CIO, workers' union

**Sean Waters**

Daimler, commercial truck manufacturing industry

**Caleb Weaver**

Uber, transportation network company

**Vacant**

Transportation union

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## Designated Alternates for Members

At the Dec. 4, 2018 meeting, the task force voted to allow each member to designate one other person from their organization as an alternate, with authority to attend meetings and vote on their behalf. In early January 2019, most members designated alternates.

Two designated alternates withdrew from the task force during the second report process, and one other alternate became a primary representative on the task force. Lt. Steve Duvall served as designated alternate for the Oregon State Police and Andrew Riley served as designated alternate for ATU; both withdrew. Evan Manvel was originally the designated alternate for the Department of Land Conservation and Development (DLCD). When Carrie MacLaren left DLCD, he became their primary representative on the task force. The list below includes only designated alternates who were serving on the task force when the final report was approved.

**Hanan Alnizami**

Jaguar Land Rover, automotive industry

**Mike Bezner**

Clackamas County, Association of Oregon Counties

**Waylon Buchan**

Oregon Trucking Association

**Miriam Cham**

Uber, transportation network company

**Carlos Contreras**

Intel Corp., AV technology industry

**Kristine Cornett**

DAS Office of the State CIO, cybersecurity industry

**Kate Denison**

Department of Justice

**Jeb Doran**

TriMet, Oregon Transit Association

**Amanda Howell**

University of Oregon, public university

**Ritchie Huang**

Daimler, commercial truck manufacturing industry

**Gail Krumenauer**  
Employment Department

**Tom McClellan**  
Department of Transportation

**Chris Muhs**  
Teamsters, transportation union

**John Powell**  
State Farm, automotive insurance industry

**Michael Rose**  
Oregon Trial Lawyers Association, trial lawyers

**Jacob Sherman**  
City of Portland, League of Oregon Cities

**Aeron Teverbaugh**  
Department of Consumer and Business Services

**Sara Wright**  
Oregon Environmental Council, nonprofit organization

**Young Walgenkim**  
Hanson & Walgenkim, LLC, consumer protection advocates

**Caleb Winter**  
Metro, metropolitan planning organization

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## Task Force Structure and Process

### Developing the Subcommittee Scopes

At the Dec. 4, 2018 meeting members weighed in on topics they would like the task force to address in the second report. They then voted to divide into six subcommittees to address the six topic areas identified in the meeting: 1) vehicle code amendments and public safety; 2) cybersecurity, privacy and data; 3) road and infrastructure design; 4) land use; 5) public transit; and 6) workforce changes. The members selected which subcommittees they preferred to join. Every member participated in at least one subcommittee, and some members participated in more than one.

Each subcommittee was led by a task force member with relevant expertise. The subcommittee leads coordinated with the Chair, set meeting agendas, led meeting discussions, and identified reference materials and experts to consult. The lead for the Subcommittee on Land Use was originally Carrie MaLaren from DLCD; Evan Manvel became the lead after MaLaren left DLCD. Galen McGill of ODOT led the Subcommittee on Road and Infrastructure Design. Jeff Owen of TriMet led the Subcommittee on Public Transit. Todd Nell of the Office of Workforce Investments led the Subcommittee on Workforce Changes. David McMorries, Chief Information Security Officer at Oregon State University, led the Subcommittee on Cybersecurity, Privacy and Data. Chair Tannenbaum led the Subcommittee on Vehicle Code Amendments and Public Safety.

Though each subcommittee had designated membership, all task force members and alternates were invited to attend and participate in any subcommittee meeting. As non-voting members of the task force, legislators were not assigned to particular subcommittees, but were welcome to attend any and all meetings.

The subcommittees discussed and voted on recommendations and materials related to their topic areas. These recommendations and materials were then discussed and voted on in meetings of the full task force. All of the background documents for the subcommittee deliberations and the minutes from each subcommittee can be found on the task force website.<sup>8</sup>

The report was approved by a vote of the full task force on Sept. 9, 2019.

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<sup>8</sup> Available at: <https://www.oregon.gov/ODOT/Get-Involved/Pages/Task-Force-on-Autonomous-Vehicles.aspx>

## Topics for Consideration by the Subcommittees

At the Dec. 4, 2018 meeting, the task force members decided on the focus areas for the subcommittees during the second report process. Every task force member also had the opportunity to contribute to the list of considerations for each subcommittee to inform the scope of work. The considerations identified were then compiled into goals, values and topics for each subcommittee to address. All of these were included in scoping documents, which were used to guide discussions in the subcommittees.

The lists of topics identified at that meeting set the range of questions and policy areas each subcommittee could consider. Because of the broad range of potential topics, every subcommittee narrowed the scope to focus on the most urgent issues and the issues supported by national guidance, studies, and data. The lists below include the broad topic areas investigated by each subcommittee. The full scoping documents are available on the task force website.<sup>9</sup>

Topics for the Subcommittee on Vehicle Code Amendments and Public Safety included:

- A comparison of vehicle code amendments related to the deployment of automated vehicles
- Guidance on the definitions of “driver,” “passenger,” and vehicles to convey the subcommittee’s intent
- Considerations for consumer protection, insurance and liability

Topics for the Subcommittee on Cybersecurity, Privacy and Data included:

- Cybersecurity
- Consumer protection and privacy
- Data sharing and intellectual property

Topics for the Subcommittee on Road and Infrastructure Design included:

- Road markings, road signs, and traffic signals
- Work zones and school zones
- Curb space management, parking and lane widths
- Vehicle-to-infrastructure communications and cybersecurity
- Broadband
- EV charging infrastructure

Topics for the Subcommittee on Land Use included:

- Critical data and enabling structures needed for land use planning
- Alignment and incentives for AVs to further Oregon’s land use, transportation, and greenhouse gas reduction goals
- Pricing, including policies for occupancy pricing and road pricing

Topics for the Subcommittee on Public Transit included:

- Identifying how automated vehicle technology could affect the distinct components of Oregon’s public transit system
- Considering how to integrate automated vehicle technology into the transit system
- Pilot opportunities

Topics for the Subcommittee on Workforce Changes included:

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<sup>9</sup> Available at: <https://www.oregon.gov/ODOT/Get-Involved/Pages/Task-Force-on-Autonomous-Vehicles.aspx>

- Current employment statistics and information about sectors that could be affected by the deployment of automated vehicles
- Strategies for addressing worker displacement and ensuring new jobs are high quality
- Strategies to ensure the incoming workforce is prepared for the new jobs available
- Elements to be included in a future independent workforce study

## Special Topic: Bicyclist and Pedestrian Safety Meeting

At the May 2, 2019 task force meeting, the members discussed the importance of ensuring the safety of vulnerable road users. They expressed interest in more directly incorporating bicyclist and pedestrian concerns into the work of the task force. On June 28, the Road and Infrastructure Design Subcommittee and the Land Use Subcommittee held a special joint meeting to discuss bicyclist and pedestrian priorities related to automated vehicles. All task force members were invited to attend.

The subcommittees received four presentations:

1. Automated Vehicles: Considerations for People Walking and Rolling<sup>10</sup>  
*Becky Gilliam, Regional Policy Manager for the Safe Routes Partnership*
2. How Do I Make Eye Contact with a Robot Car?<sup>11</sup>  
*Michael Clamann, Senior Human Factors Engineer at the University of North Carolina Highway Safety Research Center*
3. Building a Strategy for Safe Automation for All People<sup>12</sup>  
*Ken McLeod, Policy Director for the League of American Bicyclists*
4. Vision, Black Boxes, and Sophie's Choice<sup>13</sup>  
*A.J. Zelada, board member of the League of American Bicyclists, former chair of the Oregon Bicycle and Pedestrian Advisory Committee, and concerned citizen*

All four presenters conveyed the message that automated vehicle deployment could create new opportunities to support bicyclists and pedestrians, but could also create new challenges and risks. Some of the important safety concerns raised by bicyclists and pedestrians can only be addressed through federal changes to vehicle and equipment design standards, but the presenters also provided policy suggestions for state and local governments, such as:

- Ensuring automated vehicles are accessible to people with disabilities
- Considering revenue impacts and identifying solutions
- Considering the impact on public transit
- If automated vehicle deployment allows cities to repurpose parking spaces or to create narrower lanes, using the additional space to enhance livability and encourage active transportation

Many of the issues raised at the Bicyclist and Pedestrian Safety Meeting were incorporated into the task force materials, including the recommendations for public transit and automated vehicles and the impact assessments on road markings, curb space management and school zones.

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10 Available at: <https://www.oregon.gov/ODOT/Get-Involved/Documents/Becky%20Gilliam.pdf>

11 Available at: <https://www.oregon.gov/ODOT/Get-Involved/Documents/Michael%20Clamann.pdf>

12 Available at: <https://www.oregon.gov/ODOT/Get-Involved/Documents/Ken%20McLeod.pdf>

13 Available at: <https://www.oregon.gov/ODOT/Get-Involved/Documents/AJ%20Zelada.pdf>

## Special Topic: Joint Meeting on Data

In April 2019, the Land Use Subcommittee prepared a discussion memo on public sector information needs to guide automated vehicle policy and manage automated vehicle testing and deployment. The subcommittee members recognized the need for input from private industry and the overlap with topics such as cybersecurity and privacy, so they sought a joint meeting with the Subcommittee on Cybersecurity, Privacy and Data. On Aug. 14, the two subcommittees held a special joint meeting on data. All task force members were invited to attend.

The subcommittees received a presentation from Rachel Zack, a policy strategist at Remix.<sup>14</sup> Remix builds data platforms to help cities plan their transportation networks, including public transit systems and new mobility modes. Zack described different data standards cities could use, explained how Remix works with and protects sensitive data, and provided lessons learned and advice from Remix's experience with data aggregation and management.

Then, the task force members discussed how to balance concerns related to land use planning, transportation system management, protection of consumer privacy, protection of intellectual property and trade secrets, and the different challenges facing public and private entities with respect to data management.

Based on this conversation, the Land Use Subcommittee drafted data and privacy principles. At the full task force meeting on Aug. 20, the task force members decided that the draft principles needed more time, refinement, and input from other perspectives. The task force also did not vote on the memo prepared by the Land Use Subcommittee on public sector information needs to guide automated vehicle policy. However, the task force members agreed that this is an important topic deserving of further consideration.

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## Guidance and Examples

Oregon is not the first state to grapple with automated vehicle policy. Other states, federal agencies, and national organizations have also researched and made recommendations regarding this emerging technology. The task force looked to guidance from NHTSA and SAE, considered best practices from other jurisdictions, referred to studies from research institutes, and consulted with industry experts.

This section identifies the resources relied on by the entire task force and highlights presentations by experts. Because the task force addressed many disparate topics, each subcommittee prepared its own list of studies and references. These lists are included in the next section of the report, alongside the relevant materials and recommendations. Several subcommittees also prepared information on pilot projects and planning efforts undertaken by other cities, counties and states. These documents are also included in the next section of the report.

Automated vehicle technology is still in development and there is still uncertainty about when and how automated vehicles will be deployed and what the full range of impacts might be. Throughout its work, the task force acknowledged this uncertainty and based its considerations and recommendations on the best information currently available.

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14 Presentation available at: <https://www.oregon.gov/ODOT/Get-Involved/Documents/Remix%20Presentation.pdf>

## **NHTSA “Automated Vehicles 3.0: Preparing for the Future of Transportation”<sup>15</sup>**

The National Highway Traffic Administration first issued guidance on automated vehicles in Sept. 2016 and updated its guidelines in Sept. 2017. In Oct. 2018, NHTSA released a second update. “Automated Vehicles 3.0: Preparing for the Future of Transportation” clarifies federal, state, local and tribal government roles in regulating automated vehicles. It includes best practices for state legislatures and highway safety officials, and provides suggestions for how all levels of government could begin preparing for automated vehicles. NHTSA suggests reviewing laws and regulations that may need to change, adapting policies and procedures to account for automated vehicles, and assessing infrastructure elements to ensure they are conducive to the operation of automated vehicles. The task force looked to this document to ensure that Oregon’s recommendations align with federal direction on AV policy.

## **SAE “Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles,” 2018 Revision<sup>16</sup>**

The International Society of Automotive Engineers first issued its automated vehicle taxonomy and definitions in 2014, issued a revised version in 2016, and issued the current revision in June 2018. “Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles” standardizes terms and definitions related to automated vehicles. It also identifies and describes the six levels of driving automation, 0 through 5. The task force relied on the SAE “Taxonomy and Definitions” to ensure this report uses accurate terminology recognized by the automated vehicle industry.

## **Presentations from Experts**

In addition to the four presentations at the Joint Meeting on Bicycle and Pedestrian Safety and the Remix presentation at the Joint Meeting on Data, the subcommittees benefited from several additional presentations by industry experts. The Subcommittee on Workforce Changes received a presentation from K. S. Venkatraman of NVIDIA on how automated vehicles could impact the workforce.<sup>17</sup> The Subcommittee on Cybersecurity, Privacy and Data received two industry presentations on privacy: one from Uber representative Caleb Weaver and one from Jessica Simmons, Assistant General Counsel for the Auto Alliance.<sup>18</sup>

The Subcommittee on Vehicle Code Amendments and Public Safety also received a presentation from Serena Hewitt, Attorney-in-Charge of the Oregon Department of Justice General Counsel Division, Government Services Section, who explained how the terms “operator,” “driver,” “passenger” and “person” are defined in Oregon’s Vehicle Code and case law. The Subcommittee on Road and Infrastructure Design drew on expertise at ODOT; they received a presentation from Kevin Haas, ODOT Traffic Standards Engineer, on the Manual on Uniform Traffic Control Devices and how the upcoming update could address infrastructure changes precipitated by automated vehicle deployment. Michael Rock, ODOT Planning Unit Manager, also provided an update on how the agency is incorporating emerging technologies into long-range planning documents.

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15 National Highway Traffic Safety Administration, 2018.

16 Society of Automotive Engineers. 2018.

17 Available here: <https://www.oregon.gov/ODOT/Get-Involved/Documents/AVTF-workforce-NVIDIA-Presentation.pdf>

18 Available here: <https://www.oregon.gov/ODOT/Get-Involved/Documents/Auto%20Alliance%20-%20Oregon%20Privacy%20Presentation.pdf>

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## Task Force Meeting Schedule

The task force met once in 2018 on Dec. 4, and four times in 2019 on the following dates: May 2, July 25, Aug. 20, and Sept. 9.

The subcommittees of the task force each met on the dates outlined below:

### Subcommittee on Land Use

**Lead:** Evan Manvel

**Members:** Richard Blackwell, Chris Hagerbaumer, Eric Hesse, Paul Savas, Becky Steckler

**Meeting Dates:** March 6, April 10, April 19, Aug. 14

### Subcommittee on Road and Infrastructure Design

**Lead:** Galen McGill

**Members:** Marie Dodds, Eric Hesse, Jana Jarvis, Evan Manvel, Eliot Rose, Paul Savas, Sean Waters

**Meeting Dates:** Feb. 25, April 1, July 16, Aug. 15

### Subcommittee on Public Transit

**Lead:** Jeff Owen

**Members:** Eric Hesse, Becky Steckler, Graham Trainor, Sara Wright

**Meeting Dates:** March 6, July 11, Aug. 14

### Subcommittee on Workforce Changes

**Lead:** Todd Nell

**Members:** Steve Entler, Mark MacPherson, Graham Trainor, Caleb Weaver

**Meeting Dates:** March 5, April 1, April 16, July 10, Aug. 8, Aug. 15

### Subcommittee on Cybersecurity, Privacy and Data

**Lead:** David McMorries

**Members:** Richard Blackwell, Daniel Fernández, Cheryl Hiemstra, Robert Nash, Eliot Rose, Jeremiah Ross, Caleb Weaver

**Meeting Dates:** March 1, April 24, June 24, July 22, Aug. 8, Aug. 14

### Subcommittee on Vehicle Code Amendments and Public Safety

**Lead:** Lt. Tim Tannenbaum

**Members:** Marie Dodds, Daniel Fernández, Capt. Stephanie Ingraham, Neil Jackson, Robert Nash, Carly Riter, Jeremiah Ross, Sean Waters

**Meeting Dates:** March 7, April 8, May 20, July 9, Aug. 1, Aug. 12

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## Voting Results

For each subcommittee, recommendations and materials were referred to the full task force by a consensus of all subcommittee members. See minutes from the subcommittee meetings for details.<sup>19</sup>

The full task force met twice to vote on recommendations and materials from the subcommittees to be included in this report. At the July 25 meeting, all the subcommittee recommendations and materials presented were unanimously approved by the task force. At the Aug. 20 meeting, a few members abstained and three members opposed some of the materials submitted by the subcommittees. The Aug. 20 voting results on the recommendations and materials presented by each subcommittee are below. The materials and recommendations approved by the Task Force on Autonomous Vehicles are contained in the next section of the report.

### Subcommittee on Road and Infrastructure Design: Materials and Recommendations

**Ayes:** 18

**Nays:** Mark MacPherson

**Abstain:** Mike Bezner (alternate for Paul Savas), Miriam Chaum (alternate for Caleb Weaver), Ritchie Huang (alternate for Sean Waters), Gail Krumenauer (alternate for Todd Nell),

**Absent:** Richard Blackwell, Capt. Stephanie Ingraham, Graham Trainor

### Subcommittee on Cybersecurity, Privacy and Data: Materials and Recommendations

**Ayes:** 23

**Absent:** Richard Blackwell, Capt. Stephanie Ingraham, Graham Trainor

### Subcommittee on Public Transit: Materials and Recommendations

**Ayes:** 23

**Absent:** Richard Blackwell, Capt. Stephanie Ingraham, Graham Trainor

### Subcommittee on Workforce Changes: Materials and Recommendations

**Ayes:** 21

**Absent:** Richard Blackwell, Ritchie Huang (alternate for Sean Waters), Capt. Stephanie Ingraham, Carly Riter, Graham Trainor

### Subcommittee on Vehicle Code Amendments and Public Safety: Materials and Recommendations

**Ayes:** 20

**Abstain:** Miriam Chaum (alternate for Caleb Weaver)

**Absent:** Richard Blackwell, Ritchie Huang (alternate for Sean Waters), Capt. Stephanie Ingraham, Carly Riter, Graham Trainor

### Subcommittee on Land Use: Materials and Recommendations<sup>20</sup>

**Ayes:** 16

**Nays:** Marie Dodds, Jana Jarvis

**Abstain:** Miriam Chaum (alternate for Caleb Weaver), Daniel Fernández

**Absent:** Richard Blackwell, Ritchie Huang (alternate for Sean Waters), Capt. Stephanie Ingraham, Gail Krumenauer (alternate for Todd Nell), Carly Riter, Graham Trainor

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19 Available on the Task Force on Autonomous Vehicles website: <https://www.oregon.gov/ODOT/Get-Involved/Pages/Task-Force-on-Autonomous-Vehicles.aspx>

20 At the Aug. 20 meeting, the Subcommittee on Land Use presented five documents for consideration by the full task force. The task force voted on three of those documents. After a conversation amongst the task force members, Chair Tannenbaum decided not to put the last two documents, "Recommendations for Data and Privacy Principles" and "Public Sector Information Needs to Guide AV Policy," up for a vote because there was not sufficient time to discuss and resolve the task force members' concerns.

# TASK FORCE ON AUTONOMOUS VEHICLES MATERIALS AND RECOMMENDATIONS

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## **Introduction**

Because automated vehicle technology is still in development, the long-term effects of automated vehicle deployment remain uncertain. The task force based its work on the best information currently available, but recognizes that the potential impacts and recommended best practices may change as the technology continues to advance. Much of the material prepared by the task force is informational and is intended to provide the Legislature with a status update on our present understanding of automated vehicle impacts and the current state of practice. The task force also makes recommendations for steps Oregon could take now to prepare for the deployment of automated vehicles and align automated vehicle policy with existing state goals.

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# Vehicle Code Amendments and Public Safety

## Scope of the Materials and Recommendations

This section of the report contains materials prepared by the Subcommittee on Vehicle Code Amendments and Public Safety and approved by the full Task Force on Autonomous Vehicles. The subcommittee prepared three statements of intent. The first statement of intent addresses how to incorporate automated vehicles into Oregon's existing vehicle code. The remaining two statements expand on topics raised in the first statement: 1) creating new terms and definitions related to automated vehicles and 2) acknowledging that minimum insurance coverage may need to change in the future to address certain types and uses of automated vehicles.

## Statement of Intent: Incorporating Automated Vehicles into Oregon's Vehicle Code

The Task Force on Autonomous Vehicles recognizes that Oregon's existing statutes and case law for conventional vehicles were developed long before the advent of highly automated vehicles (HAVs), and that this new technology creates new concepts and roles never anticipated. The task force recommends that new statutes be included in the Vehicle Code to address roles and definitions that are unique to HAVs. It is important to ensure that these new concepts do not undermine the established statutes and case law designed for conventional vehicles. It is equally important to ensure that existing law continues to apply to automated vehicles wherever appropriate.

Currently, the Vehicle Code does not contemplate a situation in which an automated driving system (ADS), rather than a human driver, is in control of a vehicle. The deployment of HAVs will necessitate the incorporation of new concepts and language into the Vehicle Code. For example, Oregon may want to create a definition for a "fallback-ready user," a human being seated in the driver's seat of a Level 3 automated vehicle; the fallback-ready user may not be in control of the vehicle but must be prepared at all times to retake control if alerted by the ADS. Existing terminology, such as "driver," "operator," or "passenger," does not clearly encapsulate the role and responsibilities of a "fallback-ready user." The Vehicle Code needs to include new language that clearly delineates the distribution of responsibilities between human users and HAVs with different levels of automation.

However, the task force is concerned that it may not be possible to smoothly integrate HAV-specific language into our existing laws and conventional definitions. For example, in Oregon the act of "driving" arguably requires a person to exercise "actual physical control" over a vehicle. It is unclear how this requirement would apply to an automated driving system or a remote operator, both of which control a vehicle's movement without operating the physical mechanisms, such as a steering wheel or pedals, that a conventional driver would use.

Integrating new HAV-specific definitions into the current Vehicle Code will require caution and precision. If certain new definitions created for HAVs could be applied to conventional vehicles, this may undermine the strength of existing definitions or create a conflict between statute and case law. The terms "drive" and "driver" are not defined in the Vehicle Code, but decades of case law have clarified the meaning of "driver" for specific purposes. *State v. Cruz* (1993) established the meaning of "driver" for the purposes of DUII violations, and other case law has clarified the meaning of "driver" for the purposes of insurance. Creating a definition of "driver" that incorporates HAV considerations or amending other existing definitions to address HAVs could interfere with established case law around issues such as DUIIs and insurance. This could have unintended consequences for cases pertaining to conventional vehicles.

The task force also recognizes that many existing statutes and related case law will be applicable to HAVs and should therefore pertain to both HAVs and conventional vehicles. For example, HAVs will need to follow the rules of the road, stop at stop signs, and obey speed limits, just as drivers of conventional vehicles are required to do. While some laws may need to be amended to accommodate ADS operation, many laws should continue to be enforced for both automated and conventional vehicles.

The task force has also considered how personal liability principles should apply to HAV deployment. Recognizing the ability of Oregon’s tort law to adapt to new technologies, there is no clear need at this time to define duties, causes of action, or remedies beyond existing concepts. Oregon has historically accomplished this through the organic common law process. The task force believes that existing laws defining obligations to maintain insurance, minimum coverages and how and when coverages apply are currently adequate and should apply to automated vehicles. As the relationships between the various entities—owners, operators, manufacturers, insurers—develop, the insurance industry will need to create new products to accommodate those relationships and meet existing financial liability requirements to protect the general public.

Therefore, the task force believes the Legislature should exercise extreme caution when deciding how to incorporate new definitions and other statutes related to HAV technology and user roles into the Vehicle Code. The task force recommends creating new terms and definitions tailored for HAV operation, ensuring the new HAV-specific language does not adversely affect the governance of conventional vehicles, and applying existing laws to HAVs wherever appropriate.

## Statement of Intent: Definitions for Automated Vehicles

Oregon’s existing statutes governing conventional vehicles were established long before the advent of highly automated vehicles. This new technology creates new concepts and roles never anticipated. Oregon law will need to incorporate new definitions or amend existing definitions to address the changes brought about by automated vehicles.

The Task Force on Autonomous Vehicles has relied on definitions established by the International Society of Automotive Engineers (SAE). SAE published and later revised “Surface Transportation Recommended Practice J3016: Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles,” which provides common terms and definitions used across the automated vehicle industry. The document was designed to serve several purposes, including “answering questions of scope when it comes to developing laws, policies, regulations, and technical requirements.”<sup>21</sup>

However, the terms and definitions in J3016 were not designed with the Oregon Vehicle Code or other Oregon laws in mind. The task force recognizes that any new or amended definitions must align with Oregon’s existing statutory language. It is also vital that any definitions created or amended to accommodate automated vehicle operation do not undermine the existing definitions that apply to conventional vehicles.

Therefore, the task force makes the following recommendations:

1. As Oregon crafts definitions for automated vehicles, look to recommended practice from the International Society of Automotive Engineers for concepts related to driving automation systems.
2. Special consideration should be given when defining terms, such as “driver,” which have different meanings under Oregon law, depending on the context.

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<sup>21</sup> Society of Automotive Engineers. 2018.

## Statement of Intent: Acknowledgment That Insurance Minimum Coverage May Change In Some Situations

The Task Force on Autonomous Vehicles believes that existing laws defining the obligations to maintain insurance and how and when coverages apply are currently adequate for the deployment of highly automated vehicles (HAVs). However, as the relationships between the various entities—owners, operators, manufacturers, insurers—develop, policy makers will need to adjust the minimum insurance policy coverage limits to protect the general public and ensure there are ample financial resources to compensate individuals in the event of an adverse incident with an HAV that results in death, injury, and/or property damage.

The task force believes current minimum insurance policy coverage limits may be inadequate in the following scenarios in which an HAV is deployed:

- Transportation Network Companies and ride share companies operating HAVs;
- Commercial Carriers such as trucking companies that are “platooning”<sup>22</sup> HAVs;
- HAVs that have the ability to “platoon” with other HAVs;
- Commercial Carriers transporting Hazardous materials as classified by the U.S. Environmental Protection Agency;
- Common Carriers such as bus companies operating HAVs.

## Vehicle Code Amendments and Public Safety: Studies and References

### Introduction

This document is a compilation of the studies and references used or discussed in the Subcommittee on Vehicle Code Amendments and Public Safety. It also includes some relevant documents collected by ODOT staff and subcommittee members. This list is supposed to help policymakers carry out further research and to demonstrate some of the grounding for the task force’s work products.

### Studies and References

#### **Automated and Connected Vehicles: A Legal and Regulatory Roadmap**

O’Melveny

<https://www.omm.com/avl>

#### **Autonomous Vehicles: Self-Driving Vehicles Enacted Legislation**

National Conference of State Legislatures

<http://www.ncsl.org/research/transportation/autonomous-vehicles-self-driving-vehicles-enacted-legislation.aspx>

#### **Law Enforcement Protocol for Fully Autonomous Vehicles**

Arizona Department of Transportation

<https://azdot.gov/docs/default-source/motor-vehicle-services/law-enforcement-protocol.pdf?sfvrsn=4>

#### **Nuro Arizona Law Enforcement Protocol for Fully Autonomous Vehicles**

Nuro

[https://images.phoenixnewtimes.com/media/pdf/nuro-law-enforcement-protocol\\_redacted.pdf](https://images.phoenixnewtimes.com/media/pdf/nuro-law-enforcement-protocol_redacted.pdf)

#### **Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles J3016\_201806**

International Society of Automotive Engineers (SAE)

[https://www.sae.org/standards/content/j3016\\_201806/](https://www.sae.org/standards/content/j3016_201806/)

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22 Platooning is the linking of two or more vehicles in convoy, using connectivity technology and automated driving support systems.

## **Waymo Full Self-Driving Chrysler Pacifica: Emergency Response Guide and Law Enforcement Interaction Plan**

Waymo

[https://storage.googleapis.com/sdc-prod/v1/safety-report/waymo\\_law\\_enforcement\\_interaction\\_protocol\\_v2.pdf](https://storage.googleapis.com/sdc-prod/v1/safety-report/waymo_law_enforcement_interaction_protocol_v2.pdf)

## **Oregon Law**

### **Oregon Revised Statutes**

[https://www.oregonlaws.org/oregon\\_revised\\_statutes](https://www.oregonlaws.org/oregon_revised_statutes)

### **ORS 174.100 Definitions – Person**

<https://www.oregonlaws.org/ors/174.100>

### **ORS 801.370 Operation**

<https://www.oregonlaws.org/ors/801.370>

### **ORS 811.370 Failure to drive within lane; exception; penalty**

<https://www.oregonlaws.org/ors/811.370>

### **State v. Cruz, 1993**

<https://law.justia.com/cases/oregon/court-of-appeals/1993/121-or-app-241.html>

### **Sweeney v. SMC Corp, 2002**

<https://law.justia.com/cases/oregon/court-of-appeals/2002/a103085.html>

### **See also: Memorandum prepared by DOJ Staff for the Subcommittee on Vehicle Code Amendments and Public Safety, May 20, 2019**

<https://www.oregon.gov/ODOT/Get-Involved/Documents/DOJ%20Memo%20on%20AV%20Terminology.pdf>

## **Legal Definitions from Other States**

### **California**

The full text of California's autonomous vehicle rules (2018) can be found here: [https://www.dmv.ca.gov/portal/wcm/connect/a6ea01e0-072f-4f93-aa6c-e12b844443cc/DriverlessAV\\_Adopted\\_Regulatory\\_Text.pdf?MOD=AJPERES](https://www.dmv.ca.gov/portal/wcm/connect/a6ea01e0-072f-4f93-aa6c-e12b844443cc/DriverlessAV_Adopted_Regulatory_Text.pdf?MOD=AJPERES)

The full text of CA Senate Bill 1298 (2012) can be found here: [https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill\\_id=201120120SB1298](https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201120120SB1298)

### **Colorado**

The full text of Colorado Senate Bill 17-213 (2017) can be found here: [http://leg.colorado.gov/sites/default/files/2017a\\_213\\_signed.pdf](http://leg.colorado.gov/sites/default/files/2017a_213_signed.pdf)

### **Florida**

The full text of Florida Statute 316.85 (2018) can be found here: [http://www.leg.state.fl.us/statutes/index.cfm?App\\_mode=Display\\_Statute&URL=0300-0399/0316/Sections/0316.85.html](http://www.leg.state.fl.us/statutes/index.cfm?App_mode=Display_Statute&URL=0300-0399/0316/Sections/0316.85.html)

### **Georgia**

The full text of Georgia Senate Bill 219 (2017) can be found here: <http://www.legis.ga.gov/Legislation/20172018/170801.pdf>

### **Michigan**

The full text of Michigan Senate Bills 995 and 996 (2016) can be found here: <https://www.legislature.mi.gov/documents/2015-2016/publicact/htm/2016-PA-0332.htm> <https://www.legislature.mi.gov/documents/2015-2016/publicact/htm/2016-PA-0333.htm>

### **Nebraska**

The full text of Nebraska Legislative Bill 989 (2018) can be found here: <https://nebraskalegislature.gov/FloorDocs/105/PDF/Slip/LB989.pdf>

### **Nevada**

The full text of Nevada Assembly Bill 69 (2017) can be found here: [https://www.leg.state.nv.us/Session/79th2017/Bills/AB/AB69\\_EN.pdf](https://www.leg.state.nv.us/Session/79th2017/Bills/AB/AB69_EN.pdf)

The full text of Chapter 482A of the Nevada Administrative Code (2017) can be found here: <https://www.leg.state.nv.us/NAC/NAC-482A.html>

### **North Carolina**

The full text of North Carolina House Bill 469 (2017) can be found here: <https://www.ncleg.net/Sessions/2017/Bills/House/PDF/H469v7.pdf>

### **Tennessee**

The full text of Tennessee Senate Bill 151 (2017) can be found here: <https://publications.tnsosfiles.com/acts/110/pub/pc0474.pdf>

### **Texas**

The full text of Texas Senate Bill 2205 (2017) can be found here: <https://capitol.texas.gov/tlodocs/85R/billtext/pdf/SB02205F.pdf>

### **Utah**

The full text of Utah House Bill 101 (2019) can be found here: <https://le.utah.gov/~2019/bills/static/HB0101.html#41-6a-102>

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# Cybersecurity, Privacy and Data

## Scope of the Materials and Recommendations

This section of the report contains materials prepared by the Subcommittee on Cybersecurity, Privacy and Data and approved by the full Task Force on Autonomous Vehicles. The subcommittee prepared four informational documents: one addressing federal and state roles in cybersecurity, and three documents addressing privacy considerations related to automated vehicles.

The first privacy document, "Information Regarding Privacy Principles," provides information on a range of privacy considerations raised by automated vehicles. It also discusses potential measures to mitigate privacy concerns. The remaining two documents, "Geolocation Data" and "The Right to Be Forgotten," address two privacy issues in greater detail.

These documents are intended to highlight the potential privacy considerations raised by the deployment of automated vehicles. The task force acknowledges that these privacy issues are not unique to automated vehicles and apply to many different connected devices. Other deliberative bodies are considering policy changes to address privacy more holistically, and automated vehicles should be part of those discussions.

## Cybersecurity Policy

The Task Force on Autonomous Vehicles agreed that federal regulations and industry standards would provide the basis of autonomous vehicle cybersecurity. This agreement was based on the view that work done by the US Department of Transportation through the National Highway Traffic Safety Administration and industry groups such as the Society for Automotive Engineers (SAE) would be adequate to address cybersecurity design requirements in autonomous vehicles.

The task force further discussed the need to maintain open consideration for state recommendations related to cybersecurity, such as the inspection/certification of current software in autonomous vehicles as a prerequisite for operation to ensure that the software is maintained and kept up-to-date.

## Information Regarding Privacy Principles

A major concern of the Task Force on Autonomous Vehicles is how to balance the protection of individual privacy with the needs of public entities to plan, provide for services, and address historic inequalities in transportation access. Additionally, proprietary information held by industry may also be of use for these same public purposes, but must be protected from public disclosure.

The task force recognizes that privacy is a complex issue in a highly interconnected world. With few exceptions, privacy concerns are not constrained to automated vehicles, but extend to many technologies that are becoming more a part of the lives of Oregonians. The task force recommends that privacy policies related to automated vehicles align with the work of other groups, including the Attorney General's Consumer Privacy Task Force, that are considering policy or regulation to provide Oregonians reasonable privacy protections in a rapidly changing technology landscape.

The task force recognizes several important privacy tenets. First, data-collecting entities could provide a mechanism for individual "opt-in" for information not necessary for system operability to be shared, with a specified data use agreement executed by the entity receiving personal information. This would provide the

most transparency and highest control of the data by the owner of the information. The task force recommends that if the end user declines to opt-in to sharing certain information, that it not be a restriction of use, either of the automated vehicle or of public infrastructure the automated vehicle might require. Entities should not be required to provide access or service to individuals who decline to share information necessary for safety or system operability.

Second, the task force recognizes another important element of transparency: informing users about the collection and use of their data. Known as “the right to be informed,” this principle establishes that entities must provide clear, open and transparent information about how an individual’s data is being used.<sup>23</sup> One mechanism for upholding the right to be informed is the contextual notice or just-in-time notice, a brief message that appears at the moment when personal data is collected and explains how that data will be used.

Third, the task force recognizes that it is also clear that entities that hold personal information have a heightened duty to protect that data. This concept could be applied to any entity that collects sensitive information about a person in connection with use of an automated vehicle. Where a person travels can be highly sensitive, and patterns of travel can reveal sensitive information to entities that would want to influence behavior. Therefore, some are cautioning against giving away too much personal information without adequate safeguards.<sup>24</sup> Additionally, considerations in statute or regulation should be made regarding accountability, responsibility, and enforcement in regards to loss or misuse of sensitive personal information, or of proprietary industry information.

Also, for information collected by government agencies, accessing individual personal information would follow existing due process controls. State, local or tribal governments should use any personal information they hold only for the governmental purposes for which the information was gathered, and have the same heightened duty to protect that data as other entities that collect personal information. Governments using information collected from automated vehicles should also be mindful of balancing public records laws with an eye toward protecting privacy.

Fourth, an additional approach to support public policy development is to provide sufficiently depersonalized aggregate information to support public sector planning requirements. The anonymization of data means that by looking at the output of a dataset, one cannot tell whether any individual’s data was included in the original dataset or not. The goal of data aggregation and anonymization measures is to ensure that regardless of how eccentric any single individual’s details are, and regardless of the details of anyone else in the database, the guarantee of privacy still holds.<sup>25</sup> There are approaches that use statistical methods to depersonalize or anonymize information to ensure personal privacy and protect proprietary commercial information, while retaining value of analysis for public planning activities.

The State and local governments may wish to require certain elements of information, such as trip origin and destination location and occupancy of vehicle, to be made available to support public planning efforts. If consumers or industry must provide user-specific information as a condition of use of automated vehicles, the State and local governments should specify the data elements desired, the reasons for collection, provide a method for the consumer to access this data, and use and update methods for data anonymization. In an ever-data-saturated world, effective anonymization is an evolving duty. Data-collecting entities should keep in mind the principle of data minimization – that entities should collect only what is necessary. Collecting more than the necessary information can lead to higher costs of data storage, protection, and increased risk of information breach.

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23 U.K. Information Commissioner’s Office. “The Right to Be Informed.” Available at: <https://ico.org.uk/for-organisations/guide-to-data-protection/guide-to-the-general-data-protection-regulation-gdpr/individual-rights/right-to-be-informed/>

24 LaFrance, Adrienne. The Atlantic. March 21, 2016. “How Self-Driving Cars Will Threaten Privacy.” Available at: <https://www.theatlantic.com/technology/archive/2016/03/self-driving-cars-and-the-looming-privacy-apocalypse/474600/> (“In this near-future filled with self-driving cars, the price of convenience is surveillance.”).

25 Harvard University. 2014. “Harvard University Privacy Tools Project, Differential Privacy.” Available at: <https://privacytools.seas.harvard.edu/differential-privacy>.

While the nature of what and how much is collected will vary with time and needs in the dynamic environment of automated vehicles, the task force recommends a careful balance amongst protecting proprietary information, preserving individual privacy, and promoting public planning uses. The task force encourages public and private entities to dedicate appropriate expertise and resources to privacy in the future.

## Geolocation Data

### Summary

Geolocation data is data on the current or past location of devices such as GPS units and smartphones. AVs will generate geolocation data, and this data will be critical to helping public agencies plan, design and manage the transportation system to accommodate AVs safely and effectively. However, geolocation data can be used to identify people and discern details of where they live, work and travel, potentially enabling stalking and harassment and revealing sensitive destinations such as personal health appointments. A growing number of tools and best practices are emerging, especially with respect to geolocation data from shared bicycles and scooters, that can help inform how Oregon uses geolocation data to maximize the benefits of AVs while protecting people's privacy. Changes to state privacy and public records law could also help ensure responsible handling of geolocation data by all parties that collect and use this data.

The Task Force on Autonomous Vehicles makes the following recommendations for how the State of Oregon handles geolocation data generated by AVs:

- Deliver on the public value of AV data while addressing privacy concerns.
- Monitor other efforts to handle geolocation data in a way that balances utility and privacy, such as the effort to create common standards and processes for data from shared bicycles and scooters, in order to inform Oregon's approach to AV data.
- Consider developing new legislation, such as privacy laws that ensure that confidential data is protected both in public- and private-sector uses of geolocation data and/or changes to public records law that define geolocation data as confidential.

### What is geolocation data?

Geolocation data is data collected via an electronic communications network or service that indicates the position of equipment used by people who are connected to that network or service. Geolocation data can include information such as the latitude, longitude, and altitude of the equipment. Technologies that are now mainstream – particularly GPS units and smartphones – are being used to collect unprecedented amounts of geolocation data, as well as new types of data such as the time data was collected, direction of travel, and other detailed information. These technologies are expected to be integrated into AVs, so AVs will be capable of collecting and providing information on where they are located and where they have traveled in the past.

### Why do public agencies need geolocation data from AVs?

Geolocation data can provide more detailed information on where people are traveling to and from than the data sources that transportation agencies traditionally use. Agencies can use geolocation data from AVs to generally understand travel patterns and to better plan and manage the transportation system, as well as to address a number of AV-specific uses that can help make the transportation system safer and more efficient for all travelers, such as:

- Identifying facilities that could benefit from projects focused on AVs, such as connected vehicle infrastructure or dedicated AV-only lanes
- Independently evaluating AV pilot projects
- Investigating AV crashes and safety risks
- Optimizing AV travel patterns in high-demand areas or emergency situations (e.g., designating pick-up and drop-off locations in congested locations, rerouting AVs around incidents or congestion)
- Managing and enforcing regulations for transportation services that operate using AVs

Agencies have other methods of collecting some of the data needed to achieve these use cases, but these methods are all more costly and less effective than collecting geolocation data already being generated by vehicles, and it is unlikely that public agencies would be able to maximize the benefits of AVs without access to geolocation data. AVs will dramatically change how people travel, both over the long term as they inform where people live and what modes they use and also on a day-to-day basis as AVs identify the most efficient travel routes and people choose from a growing variety of transportation services based on current traffic conditions. Public agencies will need rich, up-to-date data to understand and address these rapid changes.

## What privacy risks are associated with geolocation data?

Geolocation data can be used, either alone or in combination with other data, to identify people and track their movements. A 2013 study found that people can be identified based on their travel patterns alone using as few as four data points.<sup>26</sup> It is also possible to combine geolocation data with the growing amount of other data that is accessible online to identify someone and understand where they go. A 2014 study used New York taxi data, mapping services, and social media data to identify people and their destinations, including people who used taxis to travel to strip clubs.<sup>27</sup> As a 2019 investigation in the *New York Times* highlighted, geolocation data that is collected and aggregated through smartphones and apps and that reveals individuals' detailed travel patterns is available for sale on the private market.<sup>28</sup>

A growing number of public agencies are collecting geolocation data generated by ride-hailing and shared bikes/scooters in order to manage and evaluate these services, in ways that could establish a precedent for how public agencies manage AV data. Some privacy advocates have raised concerns that agencies are collecting more data than they need and that agencies are not implementing adequate safeguards to keep data confidential, including ensuring that people are not able to obtain it through public records requests and that data cannot be used by law enforcement to profile people.<sup>29</sup> Several best practices are emerging to address these concerns, especially with respect to shared bicycles and scooters, that can inform approaches to AV data. Public agencies have updated data policies, systems, and guidelines to better project geolocation data. Open-source data standards and tools like the Mobility Data Specification (MDS)<sup>30</sup> and SharedStreets Mobility Metrics,<sup>31</sup> which are governed

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26 De Montjoye, Yves-Alexandre, Cesar A. Hidalgo, Michel Verleysen and Vincent D. Blondel. *Scientific Reports*. 2013. "Unique in the Crowd: The privacy bounds of human mobility." Available at: <https://www.nature.com/articles/srep01376>

27 Tockar, Anthony. Neustar, Inc. 2014. "Riding with the Stars: Passenger Privacy in the NYC Taxicab Dataset." Available at: <https://research.neustar.biz/2014/09/15/riding-with-the-stars-passenger-privacy-in-the-nyc-taxicab-dataset/>

28 Valentino-DeVries, Jennifer, Natasha Singer, Michael H. Keller, and Aaron Krolik. *New York Times*. Dec. 10, 2018. "Your Apps Know Where You Were Last Night, and They're Not Keeping It Secret." Available at: <https://www.nytimes.com/interactive/2018/12/10/business/location-data-privacy-apps.html>

29 For an example, see the November 2018 letter by the Center for Democracy and Technology regarding the City of Los Angeles: <https://cdt.org/insight/comments-to-ladot-on-privacy-security-concerns-for-data-sharing-for-dockless-mobility/>

30 The specification is available at <https://github.com/CityOfLosAngeles/mobility-data-specification>. A non-profit named the Open Mobility Foundation consisting of public and private members was recently formed to govern the MDS and related efforts.

31 McArdle, Mollie Pelon. Medium. "Introducing SharedStreets Mobility Metrics." Available at: <https://medium.com/sharedstreets/introducing-sharedstreets-mobility-metrics-37e4ddae8e7b>

by bodies that include both public and private-sector members, have emerged to standardize geolocation data formats and aggregate and anonymize data in a way that addresses privacy concerns while maintaining public agency use cases and creating consistency for operators. Several companies are also offering services that collect, clean, and visualize geolocation data for agencies that lack the capacity or necessary policies to manage this data.

## How do existing laws and standards treat geolocation data?

There is an emerging body of laws and guidance that treats geolocation data as confidential, but the laws that currently apply in Oregon do not designate geolocation data as confidential, nor do they limit its collection and disclosure. Public policy is generally designed to keep personally identifiable information, which is information that can be used to identify an individual, confidential, but there are different standards in current law about whether geolocation data is considered personally identifiable information. More recent privacy laws such as the European Union's General Data Protection Regulation (2019)<sup>32</sup> and the California Consumer Privacy Act (2019)<sup>33</sup> both treat location data as personally identifiable information that is subject to protections that limit its collection and disclosure, but none of these apply in Oregon. Oregon public records law requires public agencies to redact certain personal information but does not discuss geolocation data.<sup>34</sup> Both public agencies and private mobility companies have so far successfully protected geolocation data that Oregon cities are collecting from disclosure. New state legislation that defines geolocation data as confidential could make it easier for public agencies to address some of the privacy concerns discussed above in a consistent way. A more comprehensive update to state privacy law could ensure that privacy is protected both in public- and private-sector uses of geolocation data.

## The Right to Be Forgotten

"Right to be forgotten" or "right to erasure" is an element in both the European Union's General Data Privacy Regulation and regulations in Canada. Consumers generally have no effective way to understand or control what happens with the data an entity collects, where their data goes, how long the data is stored, and to whom the data is sold or shared. Often this is sensitive information, including location data, children's data, and other sensitive personal information. The right to erasure allows the consumer to ask the data-gathering company to delete what data they have on that particular consumer. Typically the right has sideboards around how the consumer must share the request, and who may ask for information to be deleted.

In order to be meaningful, data should be easy to access and erasure should be at no extra cost to the consumer. The "right to be forgotten" would be beneficial to consumer privacy, but also data security. If an entity is responsible for deleting data, then the entity may be motivated to collect only the data that is needed as part of the function of the service or product. This concept of data minimization is a simple way for entities to prevent the burden of storing, accessing, tracking, and ultimately deleting data. In other words, the less an entity collects and stores, the less the entity will need to spend on compliance for the right of erasure.

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32 EU General Data Protection Regulation: OJ L 119, cor. OJ L 127. May 23, 2018. "Chapter 1, Article 4: Definitions." Available at: <https://gdpr-info.eu/art-4-gdpr/>.

33 California Code. 2018. "The California Consumer Privacy Act of 2018: Section 4.5(7)(c)(7)." Available at: <https://oag.ca.gov/system/files/initiatives/pdfs/17-0039%20%28Consumer%20Privacy%20V2%29.pdf>

34 Oregon Revised Statutes. "ORS 192.377: Required redaction of certain personal information." Available at: <https://www.oregonlaws.org/ors/192.377>

In the autonomous vehicle context, the right to be forgotten could be especially important in several scenarios: in transfer of ownership of a vehicle, location data, ride data from a transportation network company, and in many other contexts.

The right to be forgotten will need to be balanced with competing concerns for the retention of data: public records law compliance (if shared with a government agency), subpoenas, other legal compliance concerns, and system operability.

## Cybersecurity, Privacy and Data: Studies and References

### Introduction

This document is a compilation of the studies and references used or discussed in the Subcommittee on Cybersecurity, Privacy and Data. It also includes some relevant documents collected by ODOT staff and subcommittee members. This list is intended to help policymakers carry out further research and to demonstrate some of the grounding for the task force's work products.

### Studies and References

#### **Automotive Information Sharing and Analysis Center (Auto-ISAC)**

<https://www.automotiveisac.com/>

#### **Consumer Privacy Protection Principles: Privacy Principles for Vehicle Technologies and Services**

Alliance of Automobile Manufacturers, Inc. and Association of Global Automakers, Inc.

[https://autoalliance.org/wp-content/uploads/2017/01/Consumer\\_Privacy\\_Principlesfor\\_VehicleTechnologies\\_Services-03-21-19.pdf](https://autoalliance.org/wp-content/uploads/2017/01/Consumer_Privacy_Principlesfor_VehicleTechnologies_Services-03-21-19.pdf)

#### **Global Automotive Cybersecurity Report**

Upstream Security

<https://www.upstream.auto/upstream-security-global-automotive-cybersecurity-report-2019/>

#### **Guidelines for Managing Mobility Data**

National Association of City Transportation Officials (NACTO) and International Municipal Lawyers Association (IMLA)

<https://nacto.org/managingmobilitydata/>

#### **National Cooperative Highway Research Project (NCHRP) 03-127: Cybersecurity of Traffic Management Systems**

Transportation Research Board

<https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4179>

#### **Personal Data in Your Car**

National Automobile Dealers Association and the Future of Privacy Forum

<https://fpf.org/wp-content/uploads/2017/01/consumerguide.pdf>

#### **Securing the Modern Vehicle**

Society of Automotive Engineers (SAE)

[https://www.sae.org/binaries/content/assets/cm/content/topics/cybersecurity/securing\\_the\\_modern\\_vehicle.pdf](https://www.sae.org/binaries/content/assets/cm/content/topics/cybersecurity/securing_the_modern_vehicle.pdf)

#### **Some Easy Things We Could do to Make All Autonomous Cars Safer**

Electronic Frontier Foundation

<https://www.eff.org/deeplinks/2018/03/some-easy-things-we-could-do-make-all-autonomous-cars-safer-faster>

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# Road and Infrastructure Design

## Scope of the Materials and Recommendations

This section of the report contains materials prepared by the Subcommittee on Road and Infrastructure Design and approved by the full Task Force on Autonomous Vehicles. The subcommittee prepared a summary of national guidance on AV and CV infrastructure and an overview of various state AV and CV infrastructure projects. The subcommittee also prepared twelve impact assessments, each of which examines an infrastructure element that may need to change for, or may be changed in response to, AV deployment. The impact assessments outline the best information currently available about the certainty and timing, potential co-benefits, barriers, impacts to infrastructure owner/operators, and relevant national guidance and key decision makers for each infrastructure topic. The impact assessments also identify next steps Oregon could take to prepare the state's transportation infrastructure for AVs.

The impact assessments cover a broad range of topics, which align with several of the goals identified in the Oregon Transportation Plan.<sup>35</sup> Some infrastructure elements, such as road markings or work zones, may be vital to ensuring the safe operation of AVs. Other impact assessments address complementary technologies, such as vehicle-to-infrastructure communications and EV charging infrastructure, which may not be necessary for AV operations but could enhance the potential benefits of AVs.

The impact assessment topics also vary in their certainty and projected timelines. For example, to facilitate even limited AV deployment, AVs will need to safely navigate either through or around school zones. In contrast, it is highly uncertain whether automated vehicle deployment will enable the narrowing of lanes, and such a change would only be possible once automated vehicles comprise a significant portion of the fleet.

The task force acknowledges that AV impacts on road and infrastructure design remain uncertain. The task force based these materials on the best information currently available and has provided national guidance and pilot projects to monitor for new developments, recognizing that best practices will likely change as the technology continues to advance.

## National Guidance on Road and Infrastructure Design

### Introduction

This document provides a list of national guidance relating to infrastructure for connected and automated vehicles. It is designed to be used as a starting place for policymakers considering infrastructure updates to accommodate new transportation technologies. This list is not comprehensive; additional references can be found in the footnotes of each impact assessment.

### Guidance

**SAE:** The Society of Automotive Engineers<sup>36</sup> is convening an Infrastructure Needs Related to Automated Driving Task Force. This will serve as a forum for manufacturers and infrastructure operators to exchange information.

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35 Oregon Department of Transportation. 2006. "Oregon Transportation Plan." Available at: <https://www.oregon.gov/ODOT/Planning/Pages/Plans.aspx>

36 Society of Automotive Engineers. 2019. "SAE International: The ultimate knowledge source for mobility engineering." Available at: <https://www.sae.org/>

The task force is developing a survey to distribute in the summer of 2019 to OEMs and automotive industry suppliers to gain clearer insight into the critical automated driving system needs related to road striping.

**MUTCD:** The Manual on Uniform Traffic Control Devices<sup>37</sup> is the national standard for traffic signs, signals and pavement markings. It will be undergoing an update to accommodate “technologies necessary to support highway connectivity, automation and innovations that improve safety and efficiency.”

The Federal Highway Administration planned to release this update for comment in the spring of 2019. This update is still pending.

**AASHTO Green Book:** “The Policy on Geometric Design of Highways and Streets” manual<sup>38</sup> – commonly referred to as the “Green Book” – is considered by many to be the pre-eminent industry guide to current highway and street design research and practices. It was most recently updated in September 2018. Discussions about the next edition, version 8, are in preliminary stages.

**AASHTO Coalition on National Strategy for Highway Automation:** A group of states led by Colorado have joined together in an informal pooled fund effort to develop a National Strategy for Highway Automation. The plans are to develop a strategy document covering the following eleven components: Vision, Business Case, Industry Analysis, Phased Deployment Plan, Implementation, Readiness Parameters, Return on Investment Analysis, Financial Plan, Communications Plan, and Research and Development Roadmap. The project has an accelerated schedule with each state taking on one of the topics with the goal of producing the strategy by the end of 2019.

**Cooperative Automated Transportation Coalition:** CAT<sup>39</sup> serves as a collaborative focal point for federal, state and local government officials, academia, industry and their related associations to address critical program and technical issues associated with the nationwide deployment of connected and automated vehicles on streets and highways.

The CAT Coalition is currently working on an update to the Infrastructure Owner Operator Guidelines for Supporting Cooperative Automated Transportation. The draft update is expected to be available in 2019.

**NCHRP:** The National Cooperative Highway Research Project has several projects related to connected and automated vehicles:

- **03-127: Cybersecurity of Traffic Management Systems**
  - Seeks to develop guidance<sup>40</sup> for state and local transportation agencies to mitigate cyber-attacks on traffic systems.
  - Timing: Literature review available now, project expected to conclude August 2019.
- **20-102: Impacts of CAVs on State and Local Agencies**
  - Umbrella project for much of NCHRP’s connected and automated vehicle research. \$6.5 million in funding for research allocated with 24 projects announced to date.<sup>41</sup>

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37 Federal Highway Administration. 2019. “Manual on Uniform Traffic Control Devices (MUTCD).” Available at: [https://mutcd.fhwa.dot.gov/kno\\_2009r1r2.htm](https://mutcd.fhwa.dot.gov/kno_2009r1r2.htm)

38 Association of American Highway Transportation Officials. 2018. “A Policy on Geometric Design of Highways and Streets, 7th Edition.” Available at: <https://store.transportation.org/item/collectiondetail/180?AspxAutoDetectCookieSupport=1>

39 National Operations Center of Excellence. 2019. “Cooperative Automated Transportation (CAT) Coalition.” Available at: <https://transportationops.org/CATCoalition>

40 Transportation Research Board. 2019. “NCHRP 03-127: Cybersecurity of Traffic Management Systems.” <https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4179>

41 Transportation Research Board. 2018. “NCHRP 20-102: Impacts of Connected Vehicles and Automated Vehicles on State and Local Transportation Agencies.” Available at: <https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3824>

- Timing: Several projects completed, some underway, others early in development.
- **20-102(06): Road Markings for Machine Vision**
  - Research into how marking conditions and weather affect machine vision. Preliminary results suggest daytime wet conditions most challenging; nighttime conditions easier, little lighting impact.
  - Timing: Final report was due August 2018, still not released as of the date of this report.
- **20-102(15): Impacts of CAVs to Highway Infrastructure**
  - Will produce guidance on adapting roadway and ITS designs for connected and automated vehicles. Scenario analysis based on limitations of physical infrastructure and gaps in design, operations, maintenance, technology.
  - Timing: Final report due February 2020.
- **20-102(21): Infrastructure Modifications to Improve Operational Domain of AVs**
  - Will investigate strategies for state and local agencies to improve the operational domain of automated vehicles. Strategies include I2V communications, signage, curbs and barriers, uniform and well-maintained traffic control devices.
  - Timing: Project currently under development, timeframe pending.
- **20-102(24): Infrastructure Enablers for CAVs and Shared Mobility – Near-Term and Mid-Term**
  - Will develop near-term and mid-term recommendations for infrastructure changes to enable AVs.
  - Timing: Final scope and timeframe pending.
- **03-126: Operational Standards for Highway Infrastructure**
  - Will standardize best practices for operating highway infrastructure and aims to produce a new AASHTO guidebook similar to the AASHTO Green Book, but focused on highway design elements related to Transportation System Management and Operations.
  - Timing: Initial project panel meeting and finalization of project scope is expected March 2019. The schedule for the final product development is not yet known.

**NACTO:** The National Association of City Transportation Officials is an association of 68 major North American cities and 11 transit agencies<sup>42</sup> formed to exchange transportation ideas, insights, and practices and cooperatively approach national transportation issues. They released the Blueprint for Autonomous Urbanism<sup>43</sup> in the fall of 2017 to be a resource for cities as they begin to think about transportation technology changing the urban infrastructure. NACTO plans to release an updated Blueprint in the fall of 2019.

**ITE:** The Institute of Transportation Engineers recently published a new Curbside Management Practitioners Guide.<sup>44</sup> The publication provides recommendations to help inventory, assess, enhance and prioritize the use of curb space to meet the various demands for curb space in an efficient way. The guide includes new curbside needs related to ride-hail services (TNCs) and electric vehicle charging.

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42 National Association of City Transportation Officials. 2019. "Member Cities." Available at: <https://nacto.org/member-cities/>

43 National Association of City Transportation Officials. 2017. "Blueprint for Autonomous Urbanism." Available at: <https://nacto.org/publication/bau/>

44 Institute of Transportation Engineers. 2018. "Curbside Management Practitioners Guide." Available at: <https://www.ite.org/technical-resources/topics/complete-streets/curbside-management-resources/>

**Fehr & Peers:** Fehr & Peers Transportation Consultants specialize in providing transportation planning and engineering services, and have published several studies<sup>45</sup> on automated vehicles, including research into how automated vehicle deployment could change vehicle miles traveled (VMT). In addition, Fehr & Peers has collaborated with Uber to study curb side management<sup>46</sup> in Cincinnati and San Francisco.

**FHWA:** In 2018, the Federal Highway Administration conducted a series of listening sessions around the country called the National Dialogue on Highway Automation. The intent was to gather industry input to inform FHWA on the work needed to support automated driving. The five listening session covered the following topics: Policy and Planning, Digital Infrastructure and Data, Freight, Operations, and Infrastructure Design and Safety. The presentations and handout materials from the sessions are available on the FHWA website,<sup>47</sup> but conclusions from the sessions are not yet available.

## Examples of State AV and CV Infrastructure Projects

### Background Information

#### The Intersection of Connected and Automated Vehicle Technology

Manufacturers are separately developing automated vehicle (AV) and connected vehicle (CV) technologies, and a few have indicated their intention of producing AVs that can operate without any communication links to other vehicles or infrastructure. However, many researchers and industry experts anticipate that in the future vehicles will be both automated and connected, and that combining these technologies will maximize the potential safety and mobility benefits.

Road operators and AV manufacturers are beginning to discuss potential changes to road infrastructure and design that could enable or improve AV operation, such as higher-contrast pavement markings. Infrastructure changes necessary for CVs are better understood, but have also encountered barriers to deployment.

#### Competing Connected Vehicle Communications Technologies

Connected vehicles use wireless communications systems to exchange messages with other vehicles and the driving environment. Vehicle-to-vehicle (V2V) communications refer to messages sent between vehicles, while vehicle-to-infrastructure (V2I) refers to messages exchanged with roadside equipment; the term vehicle-to-everything (V2X) refers broadly to any type of connected vehicle communication, including communications with vehicles, infrastructure, or even cell phones.

Connected vehicles could rely on one of two communications technologies: dedicated short range communications (DSRC) or cellular technology. DSRC is an open-source protocol for wireless communication that can send messages with low latency and limited interference from radio or adverse weather conditions.

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45 Fehr and Peers. 2019. "Autonomous Vehicles." Available at: <https://www.fehrandpeers.com/autonomous-vehicles/>

46 Fehr and Peers. 2019. "Curbside Management: Adapting Policy and Design to Accommodate the Changing Transportation Landscape." Available at: <https://www.fehrandpeers.com/curbside-management/>

47 Federal Highway Administration. 2019. "National Dialogue on Highway Automation." Available at: <https://ops.fhwa.dot.gov/automationdialogue/>

Connected vehicles could also rely on 5G cellular technology, which is still under development. 5G cellular technology also has the potential to transmit with low latency and could allow for more features and flexibility. 5G cellular technology has gained currency among a number of automakers and telecom providers in recent years.

In 2016, the National Highway Traffic Safety Administration (NHTSA) and US DOT initiated the federal rulemaking process to mandate use of DSRC radios in all new light vehicles by 2023, but the current administration has delayed this process and taken a technology-neutral approach to regulation. Some auto manufacturers have committed to DSRC, while others are focused on 5G. The ongoing lack of certainty around vehicle equipment and communications protocol has made it difficult for transportation agencies to spend limited funds on roadside CV infrastructure.

## **State Efforts on Infrastructure for Connected and Automated Vehicles**

This memo highlights a few efforts by states and local jurisdictions to prepare for or pilot infrastructure innovations related to connected and automated vehicles. The list below is intended to provide an overview of the variety of infrastructure projects underway and is not comprehensive.

### **FIBER**

#### **Colorado’s Smart Mobility Plan and Statewide Strategic Fiber Plan (20+ years)**

Over the past 20 years, Colorado DOT has installed or acquired approximately 1,400 miles of fiber optic cable. In some cases, Colorado DOT installed the fiber themselves, but in many cases they partnered with public and private entities, requiring that they install fiber in exchange for access to and use of the right-of-way. Colorado’s Statewide Strategic Fiber Plan is intended to create a “carrier grade network” and improve critical communications facilities.

Colorado DOT recently established a 5-10 year Smart Mobility Plan to prepare the agency’s “assets, data management, communications systems, and infrastructure to maximize the benefits of connected and autonomous vehicles.” One element of the plan is to install fiber optic cable along “Smart Mobility Corridors.” For example, in January Colorado DOT began installing 17 miles of fiber optic cable along US 24. The fiber will enable real-time access to traffic monitoring cameras, variable message signs, and traffic signals. In the future, it may also be accessible to automated vehicles and enable communication with connected vehicles.<sup>48</sup>

#### **Utah’s Fiber-Optic Broadband Expansion Agreements (20+ years)**

In 2008, Utah passed a law defining 30-year shared-use agreements with telecom services to coordinate fiber-optic broadband network development in the public right of way along state roads. UDOT policy allows telecom providers to get easy access to the right of way for continuous build-outs, which prevents any one company from having exclusive access to the right of way. UDOT installs fiber during all roadway projects in anticipation of future needs, including providing high-speed internet access to local jurisdictions and enabling operation of CVs and AVs. Utah’s goal is to connect every traffic signal and equip all roadways with communications infrastructure to provide information on roadway and weather conditions.<sup>49</sup>

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48 Colorado Department of Transportation. 2019. “Fiber Plan.” Available at: <https://www.codot.gov/programs/operations/intelligent-transportation-systems/infrastructure/planning>

49 Federal Highway Administration. 2013. “Executive Order: Accelerating Broadband Infrastructure Deployment.” Available at: <https://www.fhwa.dot.gov/policy/otps/successprac.cfm>

## INFRASTRUCTURE TO ENABLE AV NAVIGATION

### California's 6-inch Striping on I-5 (2018)

Last year, California's Department of Transportation (Caltrans) replaced striping along I-5 to increase visibility for both human drivers and automated driving systems. Caltrans widened the stripes from four inches to six inches and used thermoplastic or tape-like material rather than paint. The thermoplastic and tape contain tiny glass beads that are highly reflective and improve visibility at night and during inclement weather.

According to Donald Anderson, deputy director for maintenance and operations at Caltrans, automated vehicle manufacturers have indicated that wider stripes could help automated vehicles more accurately and reliably identify and respond to pavement markings. Preliminary results of *NCHRP 20-102(06): Road Markings for Machine Vision* indicated that high contrast is vital for automated vehicles' camera and sensor systems. The International Society of Automotive Engineers (SAE) has also convened a committee to research potential changes to infrastructure, and one of the topics under consideration is pavement markings.<sup>50</sup>

### Las Vegas' Digitized Roadways (2018-2019)

The Regional Transportation Commission of Southern Nevada (RTC) has partnered with INRIX to "digitize" key roads in Las Vegas. This process involves using INRIX AV Road Rules software to convert local map data and traffic rules into data usable by automated vehicles. This data can be used by automated vehicles to improve their functionality and make sure they can comply with local rules, such as school zones. The system also allows data from automated vehicles to be used to identify needs such as missing signage or striping.

RTC is the leading road authority in using this technology, but INRIX is working with other jurisdictions such as Boston, MA and Austin, TX.<sup>51</sup>

## TRAFFIC MANAGEMENT

### New York City Connected Vehicle Pilot (2018-2020)

Part of USDOT's Connected Vehicle Pilot Deployment Program, The New York City Connected Vehicle Project has been evaluating the safety benefits of CV technology and challenges to the deployment of the technology, especially those specific to dense urban areas. The pilot has equipped approximately 8000 vehicles with CV devices. Most of these vehicles are taxis, city buses or and other fleet vehicles. There are approximately 350 intersections equipped with RSUs. New York City Department of Transportation is using V2I and V2V communication to test safety alerts, such as alerts about sudden braking areas, and compliance messages about speed and red light violations.

The project is evaluating techniques to combat difficulties with location data that arise from NYC's "urban canyons." These methods involve dead reckoning, CAN bus integration, triangulation and others. Early testing of these efforts is said to be encouraging. The pilot has also tested an over the air update process using the DSRC technology that is deployed on the pilot vehicles and infrastructure. The NYC pilot began in August of 2018 and will continue until February 2020.<sup>52</sup>

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50 Arthur, Damon. Transport Topics. 2018. "Stripes on California Highway to Pave Way for Self-Driving Vehicles." Available at: <https://www.ttnews.com/articles/stripes-california-highway-pave-way-self-driving-vehicles>

51 Inrix. 2019. "Regional Transportation Commission of Southern Nevada First to Digitize Streets for Highly Automated Vehicles." Available at: <http://inrix.com/press-releases/av-road-rules-rtc/>

52 New York City Department of Transportation. 2019. "NYC Connected Vehicle Project." Available at: <https://cvp.nyc>

### **Tampa-Hillsborough Expressway Authority Pilot (2018-2020)**

Also part of USDOT's Connected Vehicle Pilot Deployment Program, The Tampa-Hillsborough Expressway Authority will pilot V2V and V2I technology to improve traffic congestion and safety, especially by reducing the risk of rear-end and wrong-way collisions, in downtown Tampa, FL.

Rear-end crashes are a significant problem on Tampa's Lee Roy Selmon Expressway. This pilot will use V2V among participating vehicles to warn drivers of upcoming slowdowns in traffic to combat this problem. The Expressway also features a reversible lane. This has contributed to wrong-way collisions. V2I communications will be deployed to issue warnings to potential wrong-way drivers. The V2I and V2V infrastructure will also be used for pedestrian safety, signal timing, traffic monitoring and other applications. The pilot will include 1600 private cars, 10 buses, 10 streetcars, 500 pedestrians and 40 roadside units. The pilot began operation in 2018 and will conclude in January 2020.<sup>53</sup>

### **Michigan's Connected Vehicle Test Beds (2012-Present)**

The University of Michigan researches and tests CV technology at Mcity, a 32-acre mock city constructed as a proving ground for AV and CV technology. The University has also established several on-road, real-world test beds in southeast Michigan: in Ann Arbor, Detroit, Farmington Hill, and Southfield. The Ann Arbor Connected Vehicle Test Environment is intended to be the largest operational CV deployment in the world. It began in 2012 with a three-year pilot involving 73 lane miles, 25 roadside units, and approximately 2,800 vehicles, but has now been expanded with the goal of connecting 45 street locations, 12 freeway sites, 27 square miles around the City of Ann Arbor, and up to 5,000 equipped vehicles. Using DSRC technology, the vehicles and roadside infrastructure exchange information about vehicle position, speed, direction of travel, crash warnings, ice warnings, intersection movement assist, curve speed warning, red light violation, and pedestrian detection.<sup>54</sup>

## **FREIGHT**

### **Wyoming DOT Connected Vehicle Pilot (2014-Present)**

Wyoming's I-80 is a major freight corridor, but dangerous winter driving conditions lead to many truck blowovers and crashes every year. Through US DOT's Connected Vehicle Pilot Deployment Program, Wyoming DOT is developing a system that uses V2I and V2V communications technology to improve safety and reliability for trucks traveling along I-80.

When the pilot is complete, Wyoming DOT will have installed approximately 75 roadside units (RSUs) and 400 on-board units (OBUs), including 100 on Wyoming DOT fleet vehicles and at least 150 on commercial trucks. The RSUs and OBUs communicate via DSRC technology. This technology will enable forward collision warnings, distress notifications, and alerts about speed restrictions, vehicle restrictions, weather conditions, road conditions, road closures, work zones, and crashes further down the road.<sup>55</sup>

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53 Tampa Hillsborough Expressway Authority. 2019. "THEA Connected Vehicle Pilot." Available at: <https://www.tampacvpilot.com>

54 Mcity. 2019. "On the Road." Available at: <https://mcity.umich.edu/our-work/on-the-road/>

55 Wyoming Department of Transportation. 2019. "Wyoming DOT Connected Vehicle Pilot." Available at: <https://wydotcwp.wyoroad.info>

## CONNECTED VEHICLE ECOSYSTEM

### Panasonic Partnership with Colorado DOT (2016-Present) and Utah DOT (2019-Present)

In 2016, Colorado DOT contracted with Panasonic to build a connected vehicle ecosystem, in which connected vehicles and infrastructure will be able to share data in real time. The ecosystem will also provide information to roadway operators, who can then provide road users with up-to-date alerts and better manage the transportation system. The goal is to improve safety, mobility, and reliability of Colorado's transportation system, especially once more connected and automated vehicles are on the roads.

Colorado DOT and Panasonic are outfitting fleet vehicles with communications equipment and installing roadside infrastructure along a 90-mile stretch of I-70, with 400 more miles of coverage planned for the near future. Panasonic is also developing a data processing platform capable of handling the large volume of messages that will be generated by connected vehicles and infrastructure when they are widely deployed.<sup>56</sup>

In June 2019, Utah DOT announced a similar 5-year, multi-phase partnership with Panasonic to develop an advanced transportation data network. Like Colorado, Utah DOT will begin by outfitting 30 fleet vehicles with communications technology and deploying approximately 40 roadside units to enable vehicle-to-infrastructure communications.<sup>57</sup>

## STRATEGIC PLANNING

### Minnesota DOT's Connected and Automated Vehicle Strategic Plan

In July 2019, Minnesota DOT published its Connected and Automated Vehicle (CAV) Strategic Plan, a document designed to prepare Minnesota's transportation system for rapid advancements in technology and mobility precipitated by the deployment of connected and automated vehicle technology. The plan identifies nine focus areas, including operations and maintenance, strategic staffing, and multimodal transportation. The plan also offers strategies relevant to road and infrastructure design. It is recommended that Minnesota DOT:<sup>58</sup>

- Strategically build out fiber optic and communications infrastructure to support CAV and transportation systems management and operations (TSMO)
- Update design standards to account for truck platooning
- Pilot pavement marking projects that support human drivers and CAVs
- Invest in electric vehicle infrastructure at state facilities
- Continue investments in connected vehicle test corridors to determine the resources necessary to design, operate and maintain these technologies in urban and rural environments
- Identify CAV strategies that will enhance MnDOT operations and improve traffic safety and operations
- Identify skill gaps needed to support CAV technologies, update civil service requirements, and develop a CAV talent pipe

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56 Colorado Department of Transportation. November 2016. "Panasonic to Partner with Colorado Department of Transportation to Build Connected Transportation Future." Available at: <https://www.codot.gov/news/2016-news-releases/11-2016/panasonic-to-partner-with-colorado-department-of-transportation-to-build-connected-transportation-future>

57 Descant, Skip. Government Technology. June 28, 2019. "Utah Grows Connected Vehicle Work with Panasonic Partnership." Available at: <https://www.govtech.com/products/Utah-Grows-Connected-Vehicle-Work-with-Panasonic-Partnership.html>

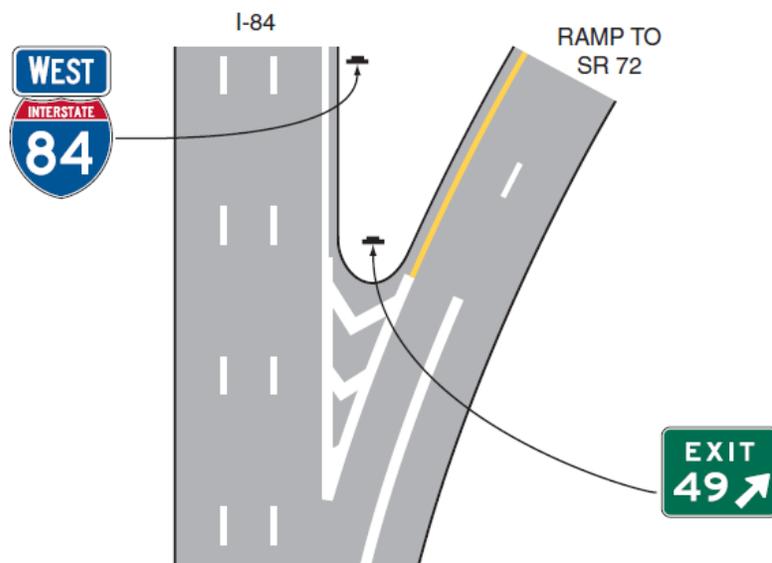
58 Minnesota Department of Transportation. July 2019. "Connected and Automated Vehicle Strategic Plan." <http://www.dot.state.mn.us/automated/docs/cav-strategic-plan.pdf>

## Impact Assessment: Road Markings

### Description

One of the key findings from a 2018 Request For Information issued by the Federal Highway Administration (FHWA) related to automated driving was the importance of consistency and quality of road markings. Machine vision systems utilized by automated vehicles (AV) require good contrast between the road marking and the surrounding pavement. Current practices related to road markings within the US vary from jurisdiction to jurisdiction, and reducing that variability would benefit automated vehicles' ability to process and interpret road markings. Specific road marking topics being considered include:

- Use of 6 inch wide markings – wider markings enable vision systems to see further ahead.
- Developing consistent skip line and gap dimensions.
- Dotted edge line extensions across ramps, cross streets, and turn lane entrances.
- Use of a black substrate under pavement markings on concrete pavements to achieve improved contrast.
- Addressing the difficulty caused by "ghost lines," i.e. old road markings left after restriping.
- The danger posed by shadow lines on road surfaces, especially those that resemble road markings.
- Although AVs will be designed to see and stop for pedestrians, crosswalks may need to be standardized and unmarked crosswalks may not be viable in an AV environment.
- Use of hatched/chevron markings in gore areas.<sup>59</sup>



**Figure 2:** Overhead Arrow-per-Lane Guide Signs for a Two-Lane Exit to the Right with an Option Lane<sup>60</sup>

59 The Manual on Uniform Traffic Control Devices (MUTCD) defined a theoretical gore as "a longitudinal point at the upstream end of a neutral area at an exit ramp or channelization where the channelizing lines that separate the ramp or channelized turn land from the adjacent through lane(s) begin to diverge, or a longitudinal point at the downstream end of a neutral area at an entrance ramp or channelized entering lane where the channelizing lines that separate the ramp or channelized entering lane from the adjacent through lane(s) intersect each other."

60 Figure 2E-4 is from pg. 195 of the current edition of MUTCD, available here: [https://mutcd.fhwa.dot.gov/pdfs/2009r1r2/pdf\\_index.htm](https://mutcd.fhwa.dot.gov/pdfs/2009r1r2/pdf_index.htm)

## **Certainty/potential time horizon**

Industry input indicates that road markings are a high priority item for enabling automated driving, and that efforts to improve standardization and perhaps improve maintenance of road markings will likely be necessary. There are short term, national efforts to identify and address road marking standards to support automated driving. Some of these items may be included in the draft version of the next Manual on Uniform Traffic Control Devices (MUTCD) that is due to be released later in 2019.

## **Co-benefits/advancing established goals**

Quality road markings are a priority for drivers today. They are particularly important during adverse weather such as heavy rainfall or fog. There is some research indicating wider road markings are beneficial for older drivers. So improved road marking would have parallel benefits for all drivers today in addition to improving automated vehicle operation.

## **Barriers**

The road marking standards being considered would increase costs for installation and maintenance of road markings. This comes in an environment where road maintenance is underfunded, and there are many competing critical needs for road maintenance funds. Standard changes that reduce flexibility and increase costs are typically met with strong resistance from jurisdictions that will be required to change practices.

It could also be more difficult and sometimes impossible to install wider lines and edge lines on narrower roads. Wider lines could reduce the space available for rumble strips, a key safety feature that can decrease road departure crashes by up to fifty percent. Wider lines could also prove more dangerous for motorcycles and bicyclists due to their slickness.

If unmarked crosswalks are no longer viable in an AV environment, this would require a change in Oregon law. Under Oregon law (ORS 811.028), every intersection is a legal crosswalk, and drivers must stop for people showing intent to cross the street at an unmarked crosswalk.<sup>61</sup> Changing the unmarked crosswalk law would necessitate a significant public education effort to ensure all road users were aware of the new practice and understood how to use crosswalks safely. As with other road marking standards, marking all currently unmarked crosswalks would also increase both installation and ongoing maintenance costs.

Extreme weather conditions might also make it difficult or impossible to maintain consistent and highly visible road markings. For example, snow and ice damage road markings, as can snow removal procedures. Poor weather conditions can also prevent infrastructure owner/operators from immediately replacing damaged road markings.

## **Impact to infrastructure owner/operator**

Implementing new road markings standards would change practices and increase project and maintenance costs for infrastructure owner/operators. For example:

- Oregon currently uses four-inch striping. Increasing striping widths to six inches would require a significant investment of time and resources across the state.
- Extending edge lines across ramp exits would increase maintenance costs because vehicles would frequently cross them and quickly wear the lines away.

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61 Oregon Revised Statutes. "ORS 811.028: Failure to stop and remain stopped for pedestrian." Available at: <https://www.oregonlaws.org/ors/811.028>

- Many crosswalks in Oregon are currently unmarked. Marking all crosswalks would increase costs for state and local transportation agencies. It would also increase maintenance costs because vehicles would frequently drive across them and wear the lines away. In addition, infrastructure owner/operators would need to engage in a significant public education campaign about any new laws governing crosswalks.
- Maintaining retroreflectivity standards may also come with an increased cost; for example, ODOT does not currently possess the equipment to test retroreflectivity on all state roads, even on a yearly basis.

There are questions about whether requirements about minimum pavement marking retroreflectivity, if implemented, will result in increased liability for agencies if they are unable to maintain markings to that standard.

### **Relevant national guidance/key decision makers**

The MUTCD sets standards for traffic control devices, including road markings. FHWA has announced that an update including some provisions for automated vehicles will be released in 2019. Any changes to road marking standards will likely occur through updates to the MUTCD.

Additional national efforts related to this topic include work by a new SAE Infrastructure Needs Related to Automated Driving Task Force. They have prioritized road markings as the first topic to work on, and they are planning a survey to be distributed to automotive industry members to gain further insight into the most critical issues related road markings and automated driving.

Additionally, research through the National Cooperative Highway Research Program is underway that is researching machine vision and road markings.

### **Next Steps**

Oregon should continue to monitor the national work underway related to this topic. The next step will be to review the draft updates to the MUTCD when it is released by FHWA. Road operators will need to develop a strategy to deal with standard changes that increase costs related to road markings.

## **Impact Assessment: Road Signs**

### **Description**

Automated vehicles (AV) employ machine vision and HD maps to navigate the roadways. They must be able to read road signs or otherwise have information about signs available in their maps. It may be more critical to maintain signs when AVs are widely deployed so that the signs remain readable to AVs. Regulatory signs are the most important category of signs to make ready for AVs followed by warning signs. Guide signs may not be a concern for AVs because AVs should already have access to the navigation information conveyed by guide signs.

One suggested approach has been the addition of infrared readable bar code markings on signs to enhance machine readability.

Electronic signs such as variable message signs need to utilize light emitting diodes (LEDs) that have a minimum refresh rate of 200 Hz to be consistently readable by machine vision systems. ODOT signs installed within the last three years have a 248 Hz refresh rate, but older signs are 121 Hz. However, ODOT publishes the sign messages via an open data portal, so a connected automated vehicle could receive the message via alternate means that wouldn't rely on machine vision systems.

Connected vehicle technology may be used to maximize the safety benefits of AVs by providing information on regulatory, warning, and guide sign messages directly to vehicle displays and systems.

### **Certainty/potential time horizon**

Automated vehicles are being developed to read road signs, but it is not clear how much standardization or change they will need.

ODOT already maintains a comprehensive inventory of all state highway signs through its sign asset management system including sign location and the type of sign. It is possible that a traffic control device interface to AVs connecting the ODOT sign inventory to the vehicle could be developed.

### **Co-benefits/advancing established goals**

Improving the standardization and visibility of signs will offer safety benefits for human motorists as well as automated vehicles.

The delivery of regulatory, warning, and guide sign messages directly to the vehicle promotes safety. The vehicle would have access to information such as speed limits, safe speeds for curves, school zones, pedestrian crossings, and any other information typically conveyed by a highway sign.

### **Barriers**

The road sign standards being considered would increase costs for installation and maintenance. This comes in an environment where road maintenance is underfunded, and there are many competing critical needs for road maintenance funds. Standard changes that reduce flexibility and increase costs are typically met with strong resistance from jurisdictions that will be required to change practices.

The National Highway Traffic Safety Administration (NHTSA) has refrained from establishing standards for connected vehicle communication, making it difficult to develop technology for competing standards and platforms.

FHWA currently regulates traffic control devices and how that information is conveyed through the Manual on Uniform Traffic Control Devices (MUTCD). However, states have pushed back against previous efforts to create greater standardization in the MUTCD.

Upgrading variable message signs to meet the LED refresh rates required for machine vision systems would be cost prohibitive.

### **Impact to infrastructure owner/operator**

Costs to state agencies will include a more robust quality assurance and control process for keeping the ODOT sign asset management system current so the information can be used in a real-time AV environment. Developing a vehicle interface to the ODOT sign asset management system could also be expensive.

Work to standardize signs and keep them adequately maintained for machine vision would be an added cost.

A small number of signs in Oregon do not meet retroreflectivity standards and would need to be replaced.

## Relevant national guidance/key decision makers

The Federal Highway Administration (FHWA) regulates traffic control devices through publishing and maintaining the MUTCD. The next edition of the MUTCD, due to be released in 2019, is expected to include language addressing AVs and traffic control devices. NHTSA has responsibility for regulating the automobile industry but so far has not established standards for vehicle-to-infrastructure communications technology. The lack of vehicle-to-infrastructure standards has led to multiple competing platforms and lack of investment.

## Next steps

Continue investment and experimentation with technology for connected vehicle applications related to traffic signs. Such systems could potentially be used to convey road sign information as well.

Evaluate the status of ODOT's sign database.

As cost-effective, ensure future agency electronic sign purchases meet the 200 Hz minimum refresh rate requirement.

## Impact Assessment: Traffic Signals

### Description

The goal of intelligent signals is to provide more efficient movement and increase the safety of pedestrians, bicyclists, and vehicle operators.

Smart traffic signals communicate with vehicles to provide messages that can inform drivers about the timing of signals. Some signals may also be capable of using information from vehicles to alter signal timing to improve efficient movement of freight or communicate with pedestrians to improve pedestrian safety.

For example, several transit authorities are operating pilots with signal prioritization for transit buses to improve the reliability of their transit systems. Prioritization of freight in particular could provide emissions benefits by minimizing idling. Traffic signals with connectivity can also allow for more efficient management of the transportation system.

These connected signals could communicate with automated vehicles to improve their operation and safety. Automated vehicles could match their speed to pass through traffic signals at ideal times based on instructions from the signals. The signals could also be part of a network communicating crash or other hazard data to approaching AVs.

ODOT has implemented an internet based data portal to share signal phase and timing (SPaT) and map messages to enable earlier adoption of some of the connected vehicle traffic signal applications.

Automated vehicles might require physical changes to traffic signals to accommodate machine reading. Industry has indicated that greater national uniformity in traffic signal design and implementation would be helpful. Signals should have a clear association with the specific lane each signal is for. Light emitting diode light modules need to have a refresh rate that is greater than 200 Hz.<sup>62</sup>

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62 Auto Alliance. February 25, 2019. "TCD Suggestions for Automated Driving Systems (ADS)." Available at: <https://www.itsrm.org/national-committee-on-uniform-traffic-control-devices-connected-automated-vehicle-cav-task-force-tcd-suggestions-for-automated-driving-systems-ads-feedback-from-automotive-oems/>,"

## **Certainty/potential time horizon**

Smart signals already exist and are being installed around the country, including in Oregon. They are an example of a connected vehicle technology that could improve safety by communicating with both conventional and automated vehicles.

The extent to which automated vehicles will require more standardized, readable traffic signals is uncertain at this time.

## **Co-benefits/advancing established goals**

Smart signals are expected to enhance safety for all road users, with a greater impact as more vehicles are able to communicate with the infrastructure. They also can improve the flow of traffic and reduce emissions by helping vehicles spend less time idle at intersections. Smart signal technology can protect pedestrians and other vulnerable road users by altering signal timing based on pedestrian traffic.

## **Barriers**

Cost of installation of the technology and the lack of an agreed upon standard for vehicle-to-infrastructure technology.

Many owner/operators rely on legacy equipment for their traffic signals. Upgrading these older signals would represent a major overhaul in these jurisdictions.

## **Impact to infrastructure owner/operator**

Costs will include installation of connected vehicle infrastructure, as well as building the organizational capacity needed to establish, manage, and maintain the system on an ongoing basis.

## **Relevant national guidance/key decision makers**

Traffic signal designs are somewhat standardized in the MUTCD. The federal government has maintained a technology neutral stance regarding DSRC and 5G, although the FCC has reserved some of the 5.9 GHz band for DSRC vehicle safety applications. The Society of Automotive Engineers (SAE) standard J2735 specifies the SPaT and Map message set standards for traffic signal to vehicle communication of signal operation details.

The US DOT Intelligent Transportation Systems Joint Program Office is leading an effort called the Connected Vehicle Reference Implementation Architecture (CVIRA). The goal of CVIRA is to identify and encourage standards for connected vehicle technologies.

The forthcoming update to the MUTCD could address changes to traffic signal standards to accommodate machine vision.

## **Next steps**

Track the progress of updates to the MUTCD.

Monitor industry direction related to use of the 5.9 GHz spectrum for vehicle to infrastructure communications. Support preservation of the 5.9 GHz band for transportation safety purposes.

Update signal controllers to a modern signal controller and connect signals to central systems where possible.

Implement an internet data sharing portal for SPaT and Map messages from connected signals.

## Impact Assessment: Work Zones

### Description

Work zones present some of the most challenging environments for automated vehicles due to highly variable conditions and the need to sometimes navigate outside the normal road markings and travel lanes. The presence of construction vehicles in addition to regular traffic adds to this complexity.

To safely respond to work zones, automated vehicles must safely navigate roads that require the vehicle to stop, change direction or disregard the standard rules of the road. Work zones often require vehicles to respond to flaggers or other devices and be directed around the work zone while ignoring the existing striping. Many work zones on high speed facilities use channelization devices to move vehicles to open lanes while also ignoring the existing striping. Automated vehicles will need to react to this variation of travel outside of the usual protocol of following road striping. Also, in many work zones, construction vehicles are present in addition to conventional traffic flows.

Connected vehicle technology could alleviate this problem by helping automated vehicles identify or avoid work zones. For example, connected vehicle technology could allow for real-time data about work zones to be transmitted to approaching vehicles. These alerts would include information about lane closures, speed limits, and the parameters of the work zone. This would be a completely new data source that is not currently being transmitted.

The safety of people in work zones is paramount, and allowing technology to communicate to automated vehicles directly about their exact location has the potential to save lives. Virginia Tech is evaluating wearable connected technology installed in road crew member's high visibility vests to address this issue.<sup>63</sup>

Infrastructure owner/operators can also provide data regarding work zones directly to AV manufacturers/AVs. US DOT has developed a work zone data standard to allow infrastructure owners and operators to standardize and share work zone data with manufacturers specifically to aid in navigating work zones. ODOT currently gathers information about construction and shares that data through an open data portal. ODOT also provides a web based tool allowing local agencies to share information about construction and other road incidents through that same data portal.

Another potential solution for gathering work zone data is using intelligent traffic control equipment, such as upgraded arrow boards or smart cones, that can automatically share data about lane closures based on their activation and use. This data could allow a transportation agency to receive and share more accurate, real-time data about work zone operations on their roads.

Another potential solution for AVs to safely navigate through work zones is by having AV manufacturers utilize remote operators who can pilot AVs when they encounter work zones or other difficult circumstances. While this may work for the occasional vehicle, using this technology with a large number of vehicles is prohibitive.

Automated vehicles will also have to interact with flaggers and other road crew members in work zones. Safety in these environments might be improved if automated vehicles have some method to communicate their intentions and reassure pedestrians and road construction workers. For example, Jaguar Land Rover has tested an automated vehicle equipped with electronic eyes that look at pedestrians to demonstrate the vehicle has noticed them.<sup>64</sup>

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63 Hodgkins, Kelly. *Digital Trends*. Sept. 8, 2015. "Virginia Tech has developed a smart safety test that alerts road workers before a collision occurs." Available at: <https://www.digitaltrends.com/cool-tech/connected-safety-vest/>

64 Holley, Peter. *The Washington Post*. Sept. 2, 2018. "To earn trust for autonomous vehicles, Jaguar gives them 'virtual eyes.'" Available at: <https://www.seattletimes.com/business/to-earn-trust-for-autonomous-vehicles-jaguar-gives-them-virtual-eyes/> <https://www.seattletimes.com/business/to-earn-trust-for-autonomous-vehicles-jaguar-gives-them-virtual-eyes/>

## **Certainty/potential time horizon**

Automated vehicles will need to be able to safely navigate work zones. It is uncertain whether automated vehicle manufacturers will design AVs capable of safely navigating work zones without outside input, or whether connected vehicle or other technology will be needed to address these situations.

## **Co-benefits/advancing established goals**

Connected vehicle roadside equipment for work zones could improve safety for both motorists and work crews. The improvements in safety will be greater with a larger saturation of connected vehicles. It could provide safety benefits for conventional vehicles as well.

Data sharing between infrastructure owners and operators and automated vehicle manufacturers could provide benefits beyond the safe operation of AVs. Transportation agencies could receive data that would allow them to better manage and design their transportation systems.

## **Barriers**

Construction zones may be too unpredictable for automated vehicles to assess.<sup>65</sup> Automated vehicles are not currently capable of responding to hand signals from construction crews and the array of cones, construction vehicles and crews on the road.

Since construction sites change constantly, it will be difficult for automated vehicle technology to “learn” to read the area.

Current work zone reporting processes don’t gather data at the specificity required for automated vehicles. Also, current process don’t include data gathering for utility work or other permitted construction work that occurs on the road system. Gathering more accurate, real-time work zone status information would require implementing new, more uniform and disciplined reporting procedures.

Implementing smart work zone traffic control technology would require agencies and contractors to upgrade equipment and would require investment in systems for storing, analyzing and communicating the additional data.

## **Impact to infrastructure owner/operator**

Costs would include installation of connected vehicle infrastructure, as well as building the organizational capacity needed to establish, manage, and maintain the system on an ongoing basis. There would also be additional costs for acquiring, storing and analyzing new data from work zones.

Keeping detailed and up-to-date work zone data would require owner/operators to change some of their reporting practices. It would also cost time and resources to train staff and contractors, particularly if new technology is utilized.

## **Relevant national guidance/key decision makers**

The federal government has maintained a technology agnostic stance regarding DSRC and 5G, although the FCC has reserved some of the 5.9 GHz band for DSRC vehicle safety applications.

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65 Technology.org. Oct. 13, 2018. “Autonomous Vehicles and Construction Sites: Technological Challenges and Possible Solutions.” Available at: <https://www.technology.org/2018/10/13/autonomous-vehicles-and-construction-sites-technological-challenges-and-possible-solutions/>

US DOT has launched a policy initiative called Data for Automated Vehicle Integration (DAVI). The goal of DAVI is to identify and address data sharing needs for AVs to be integrated safely into the transportation system. One component of DAVI is the Work Zone Data Exchange (WZDx) Specification. This is an effort to standardize work zone data so that it can be shared among data owners and automated vehicles to improve safety.

## Next steps

Pilot or invest in roadside communication devices in work zones or connected vehicle systems in work vehicles. Engage in dialogue with AV manufacturers about data needs for V2I and V2V.

Consider investments in connected work zone arrow boards and other technology.

## Impact Assessment: School Zones

### Description

To ensure safety in school zones, automated vehicles will need to adjust to rules that vary at different times of day or by local conditions and navigate areas with high volumes of pedestrians, including young children. The safety of students, parents, and teachers in school zones is critically important, and manufacturers must design vehicles that sense and respond appropriately to all pedestrians.

Current signage around schools may be too complex and use too many words for automated vehicles to react appropriately. It is uncertain if automated vehicles will be able to react appropriately to school zone signs with conditional instructions, such as “when children are present.”

Additionally, there is a fair amount of variability in school zone signing. A higher degree of standardization would be helpful for machine vision systems. One suggested approach has been the addition of infrared readable bar code markings on signs to enhance machine readability.

Machine vision systems also cannot reliably interpret light emitting diode (LED) signs. LED modules associated with school zone signs should have a refresh rate of 200 Hz or greater to ensure they are readable by machine vision systems.

Connected vehicle technologies could improve school zone safety by helping automated vehicles identify or avoid schools zones. For example, connected vehicle technology could allow for real-time data about school zones to be transmitted from roadside units or other infrastructure to approaching vehicles, allowing them to follow the necessary procedures.

Infrastructure owner/operators can also provide data regarding school zones to AV manufacturers/AVs. US DOT is leading a project to allow infrastructure owners and operators to standardize and share data with manufacturers specifically to aid in navigating work zones, which may be applicable to school zones as well.

Automated vehicles will also have to interact with crossing guards and pedestrians in school zones. Safety in these environments might be improved if automated vehicles have some method to communicate their intentions to and reassure pedestrians. For example, Jaguar Land Rover has tested an automated vehicle equipped with electronic eyes that look at pedestrians to demonstrate the vehicle has noticed them.<sup>66</sup>

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66 Holley, 2018.

## **Certainty/potential time horizon**

It is uncertain when automated vehicles will be deployed for commercial use. It is also uncertain whether automated vehicle manufacturers will design AVs capable of safely navigating school zones without outside input, or whether connected vehicle technology or other solutions will be needed to address these situations.

## **Co-benefits/advancing established goals**

Connected vehicle roadside equipment for school zones could improve safety for both motorists and pedestrians. The improvements in safety will be greater with a greater saturation of connected vehicles.

Data sharing between infrastructure owners and operators and automated vehicle manufacturers could provide benefits beyond the safe operation of AVs. Transportation agencies could receive data that would allow them to better manage and design their transportation systems.

## **Barriers**

Cost of creating or subscribing to platforms to share information among the vehicles and infrastructure operator/owners where school zones are located.

Uncertainty about whether connected vehicle applications will rely on dedicated short-range communications (DSRC) technology or 5G cellular technology. This has prevented both private companies and public agencies from investing in connected vehicle infrastructure.

## **Impact to infrastructure owner/operator**

Costs would include installation and maintenance of the connected vehicle infrastructure, including training staff on new technology and procedures.

If signage for school zones is standardized or requires additions such as infrared-readable barcodes, infrastructure owners and operators will incur additional costs replacing non-compliant signage.

## **Relevant national guidance/key decision makers**

The federal government has maintained a technology-agnostic stance regarding DSRC and 5G, although the FCC has reserved some of the 5.9 GHz band for DSRC vehicle safety applications.

US DOT has launched a policy initiative called Data for Automated Vehicle Integration (DAVI). The goal of DAVI is to identify and address data sharing needs for AVs to be integrated safely into the transportation system.

## **Next steps**

Pilot or invest in roadside communication devices in school zones. Begin consolidating information about road systems and rules in one accessible place. Engage in dialogue with AV manufacturers about data needs. Monitor updates to the Manual on Uniform Traffic Control Devices for changes to school zone sign design requirements.

# Impact Assessment: Vehicle-to-Infrastructure (V2I) Communications

## Description

Connected vehicles use wireless communications systems to exchange messages with other vehicles and the driving environment. Vehicle-to-vehicle (V2V) communications refer to messages sent between vehicles; V2V communications are already being tested in pilots around the country and could have especially important applications for commercial vehicles. Vehicle-to-infrastructure (V2I) communications refer to messages exchanged with roadside equipment. The term vehicle-to-everything (V2X) refers broadly to any type of connected vehicle communication, including communications with other vehicles, infrastructure, or even cell phones. For example, V2X technology could improve vehicle awareness of bicyclists and pedestrians, which could enhance safety for vulnerable road users. This type of technology could also allow other road users to communicate with connected infrastructure; for example, it might allow traffic signals to exchange messages with connected devices belonging to vulnerable road users, thereby ensuring they have sufficient time to safely cross the street.

This assessment focuses on vehicle-to-infrastructure (V2I) communication, wireless communication between connected vehicles and digital systems linked to transportation infrastructure, usually through communication devices called "roadside units" installed near roadways. V2I communication can utilize dedicated short-range communications (DSRC), cellular technology or sometimes Wi-Fi.<sup>67</sup>

V2I technology can be used to communicate a wide range of information. Examples include advisories about approaching slowdowns, signal timing information, information about hazardous weather conditions and pedestrian detection.

Many experts expect automated vehicles to also use connected vehicle technology. Vehicle-to-infrastructure communication could enhance automated vehicles' safety, especially in areas with variable rules of the road such as school zones, and improve the flow of traffic by integrating data about transportation infrastructure, traffic conditions and signal timing with automated driving system behavior.

## Certainty/potential time horizon

V2I technology is already being deployed throughout the U.S., including in Oregon. The extent to which automated vehicles will integrate or require V2I features is highly uncertain.

## Co-benefits/advancing established goals

V2I technology can provide safety benefits, improve the flow of traffic and provide more accurate and up-to-date information for the management of the transportation system through driver assistance features, whether or not automated vehicles make use of the technology.

## Barriers

In 2016, the National Highway Traffic Safety Administration (NHTSA) and US DOT initiated the federal rulemaking process to mandate use of DSRC radios in all new light vehicles by 2023, but the current administration has delayed this process and taken a technology-neutral approach to regulation. This uncertainty about whether connected vehicle applications will rely on DSRC technology or 5G cellular technology has prevented both private companies and public agencies from investing in connected vehicle infrastructure.

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<sup>67</sup> Federal Highway Administration. December 2015. "Connected Vehicle Impacts on Transportation Planning, Technical Memo #5: Case Studies." Available at: [https://rosap.ntl.bts.gov/view/dot/31430/dot\\_31430\\_DS1.pdf?](https://rosap.ntl.bts.gov/view/dot/31430/dot_31430_DS1.pdf?)

The FCC has reserved some of the 5.9 GHz band for DSRC vehicle safety applications. However, the FCC recently raised the possibility of opening up the 5.9 GHz band for use by unlicensed Wi-Fi networks, which makes the future of DSRC-enabled V2I applications more uncertain.

The extent to which automated vehicles will integrate V2I technology is uncertain, and this will be a barrier to any development of that technology until there is a clearer picture of how these vehicles will operate.

Most V2I messages do not broadcast individual- or vehicle-specific information, but concerns about protecting individual privacy would also need to be addressed.

For more information about cybersecurity issues, see the Impact Assessment of Cybersecurity for V2I Communications.

### **Impact to infrastructure owner/operator**

Costs will include installation and maintenance of connected vehicle infrastructure, as well as building the organizational capacity needed to establish, manage and maintain the system on an ongoing basis. The ability to receive messages from vehicles introduces new cybersecurity risks for agency systems and networks that need to be mitigated.

V2I infrastructure will likely rely upon the broadband infrastructure and digital networks that underpin existing intelligent transportation systems infrastructure where present and may qualify for federal programs to aid ITS deployment.<sup>68</sup>

### **Relevant national guidance/key decision makers**

The federal government has supported CV technology, but it has maintained a technology agnostic stance regarding DSRC and 5G, although the FCC has reserved some of the 5.9 GHz band for DSRC vehicle safety applications.

The Cooperative Automated Transportation (CAT) coalition, a collaborative effort by the American Association of State Transportation Officials (AASHTO), the Institute of Transportation Engineers (ITE), and the Intelligent Transportation Society of America (ITS America), provides leadership and support for V2I technology deployment.

The US DOT Intelligent Transportation Systems Joint Program Office is leading an effort called the Connected Vehicle Reference Implementation Architecture (CVIRA). The goal of CVIRA is to identify and encourage standards for connected vehicle technologies.

The Federal Highway Administration (FHWA) has also released V2I resources and guidance.<sup>69</sup>

### **Next steps**

Follow the progress of the federal connected vehicle pilot projects and benefit from the lessons learned on those projects. Monitor the National Operations Center of Excellence website page for Connected and Automated vehicle resources for updated information and webinars on this topic.

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68 Federal Highway Administration. December 2015. "Connected Vehicle Impacts on Transportation Planning, Technical Memo #5: Case Studies."

69 U.S. Department of Transportation. 2017. "FHWA Announces Vehicle-to-Infrastructure Guidance." Available at: <https://www.transportation.gov/briefing-room/fhwa0317>

Evaluate locations for the deployment of V2I equipment, especially those where deployment can leverage existing ITS infrastructure, such as broadband connections and smart traffic signal controllers, to reduce cost. Invest in ITS systems that have the capacity to accommodate V2I equipment. Hire and develop a workforce with the technical expertise to maintain V2I equipment.

Identify opportunities to pilot V2I technology to gain experience with V2I equipment and develop staff capabilities.

## Impact Assessment: Cybersecurity for Vehicle-to-Infrastructure (V2I) Communications

### Description

Vehicle-to-infrastructure communication, or V2I, is the term for wireless communication between connected vehicles (CV) and digital systems linked to transportation infrastructure, usually through communication devices installed near roadways, called roadside units. Vehicle-to-infrastructure communication can utilize dedicated short-range communications (DSRC), cellular technology or sometimes Wi-Fi.<sup>70</sup>

Many experts expect automated vehicles to also use connected vehicle technology. V2I communication could enhance automated vehicle safety, especially in areas with variable rules of the road such as school zones or work zones, and improve the flow of traffic by integrating data about transportation infrastructure, traffic conditions and signal timing with automated driving system behavior.

While emerging transportation technologies could help reduce crashes, congestion, and greenhouse gas emissions, increased utilization of advanced computing systems and software also increases the potential for cyberattacks. Cybersecurity breaches in a CV system could pose immediate safety risks and lead to crashes or other dangerous situations on the road. Because many of the regularly transmitted CV messages include speed and position data, this information could be used to track a specific user, violating the individual's privacy. In addition, cybersecurity breaches could undermine trust in CV systems; if drivers cannot trust information received through V2I messages, they will be less likely to take action based on those messages, diminishing the safety and efficiency benefits of CV technology.

The U.S. Department of Transportation (US DOT) has identified four elements to securing connected vehicle systems, including vehicle cybersecurity, infrastructure cybersecurity, ITS architecture and standards security, and communications security.<sup>71</sup> The federal government has sole authority to establish cybersecurity standards for vehicles and equipment. This impact assessment examines communications security.

As noted above, DSRC is not the only technology that can be utilized for V2I communications. However, most security research to date has focused on DSRC. In 2018, the Center for Transportation Research noted that DSRC is inherently resilient to some kinds of cyber-based attacks. However, the same report notes that, similar to Wi-Fi,

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70 Federal Highway Administration. December 2015. "Connected Vehicle Impacts on Transportation Planning, Technical Memo #5: Case Studies."

71 U.S. Department of Transportation. "How the U.S. Department of Transportation Is Protecting The Connected Transportation System from Cyber Threats." Available at: [https://www.its.dot.gov/factsheets/pdf/cybersecurity\\_factsheet.pdf](https://www.its.dot.gov/factsheets/pdf/cybersecurity_factsheet.pdf)

it can be susceptible to a wide range of attacks that could result in denial of service, loss of confidentiality, or degraded system integrity. The report acknowledges that more research is necessary to understand these attacks and design compensating measures.<sup>72</sup>

While no single technology can provide security against all types of attacks, cryptographic systems will assuredly play a major role in ensuring the trustworthiness of V2I communications. To that end, the US DOT and partner organizations have created a proof-of-concept communications security system,<sup>73</sup> called the Security Credential Management System (SCMS), designed to be used in federal CV pilots. The SCMS uses a public key infrastructure (PKI)-based authentication method to create, manage, distribute, use, store and revoke digital certificates. In the proof-of-concept project, the SCMS issues multiple digital certificates to users and constantly alters the certificates to preserve privacy. The certificates contain no information that could be used to identify individuals or pieces of equipment, but serve as system credentials so that other users can trust their messages. However, a full-scale deployment will require more research, investment and a business model that will sustain the SCMS over time.

The US DOT has identified lessons learned and considerations for an SCMS deployment. Ongoing considerations include how on-board units (OBUs) can trust certificates from more than one authorized entity, the rules specifying how certificates are issued and retired over time, the manner in which certificates are replaced, and the legal or policy framework which allows certificates to be revoked when bad actors are identified.<sup>74</sup>

## **Certainty/potential time horizon**

V2I technology is already being tested, including in Oregon. The extent to which automated vehicles will be deployed with or will require V2I features is highly uncertain. Deployments of V2I technology will require cybersecurity systems.

## **Co-benefits/advancing established goals**

To deploy V2I technology, the security of the communications has to be ensured. Securing V2I communications is essential to prevent attacks that, if successful, could lead to crashes and other dangerous road incidents. It is also essential to protect the privacy of individual users. Generally speaking, securing V2I communications is essential to prevent loss of trust in CV systems and ensure the full potential safety and traffic management benefits of CVs are realized.

## **Barriers**

It is uncertain whether V2I communications will rely on DSRC or 5G technology, which has prevented both private companies and public agencies from investing in CV infrastructure. To date, published research regarding cybersecurity for V2I communications has focused on DSRC technology.

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72 Bhat, Chandra. Center for Transportation Research. Feb. 1, 2018. "Cybersecurity Challenges and Pathways in the Context of Connected Vehicle Systems." Available at: <https://rosap.ntl.bts.gov/view/dot/37194>

73 U.S. Department of Transportation. January 12, 2018. "National Security Credential Management System: SCMS Baseline Summary Report." Available at: <https://rosap.ntl.bts.gov/view/dot/36397>

74 Kolleda, Joshua, Tyler Poling, Scott Andrews, David Fitzpatrick. U.S. Department of Transportation. June 22, 2018. "Full-Scale Security Credential Management System (SCMS) Deployment: Workshop Read Ahead." Available at: <https://rosap.ntl.bts.gov/view/dot/36651>

It is also uncertain what level of government will have authority to implement and oversee the cybersecurity of V2I communications. For example, laws and regulations defining misbehavior that results in certificate revocation could be set by the federal government or by states and local governments. In either case, multiple departments and multiple levels of government will likely need to coordinate inspections and incident response and to enforce compliance with CV requirements.

A full-scale, secure SCMS system would require an ownership and governance model that ensures effective governance and consistent funding. Otherwise, there could be issues with availability and inconsistent services, resulting in varying security, privacy and device standards across components and geographic areas. This could negatively impact interoperability, but it could also create vulnerabilities and expose the system to interference.<sup>75</sup>

Depending on the ownership and governance model, industry competitors may need to participate in the system and would need to work together to ensure the system operates effectively and safely. One example is the payment card industry (PCI), in which competing companies (such as Visa and Mastercard) established a council to set privacy and security standards, run training programs, and annually certify adherence to the standards.

Additional research is required to address some of the cybersecurity vulnerabilities of CV systems, especially vulnerabilities related to interference and confidentiality.

### **Impact to infrastructure owner/operator**

State and local governments that operate network connected roadside infrastructure already have requirements for implementing security measures. The ability to receive messages from external entities such as a connected vehicle creates additional cybersecurity complexity. The federal government has taken primary responsibility for deploying a security credential management system for CV technology, but development of a system is proceeding slowly. State and local governments will need to implement SCMS technology for infrastructure points where V2I communications is enabled, but this is not possible until national standards and a sustainable business model are defined. Regulating and overseeing cybersecurity for the vehicle end of V2V or V2I communications will likely remain the responsibility of the federal government. However, if federal standards don't develop fast enough to meet needs, state and local governments could be required to take an expanded role in securing V2I and V2V communications.

Any state or local role in V2I communications security would require building organizational capacity, including hiring and training staff and investing in new systems. State and local agencies would also likely need to establish an ongoing source of funding for efforts related to V2I communications security because outdated CV communications technology could create cybersecurity risks. Contracts with companies with cybersecurity expertise may be required to audit systems and review agency cybersecurity procedures.

### **Relevant national guidance/key decision makers**

The Intelligent Transportation Systems Joint Program Office (ITS JPO) and the National Highway Traffic Safety Administration (NHTSA) partnered with the automotive industry and security experts through the Crash Avoidance Metrics Partnership (CAMP) to create the SCMS proof-of-concept communications security system for connected vehicle pilots and other federally-funded V2X efforts. The goals for the SCMS project include defining a governance strategy for a full-scale SCMS, establishing an SCMS manager and hierarchy, and identifying roles and responsibilities for all the system participants.<sup>76</sup>

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75 Ibid

76 Ibid

Another research effort is the European Commission's Cooperative Intelligent Transportation System Trust Model concept. This concept envisions an infrastructure that provides redundancy and interoperability, allowing for more flexibility in expanding and decentralizing its operations. Initial next steps will include development of a working prototype at the European level. Work on design and implementation of the prototype has already begun.<sup>77</sup>

### **Next steps**

Monitor US DOT's SCMS project for updates and observe AV pilots where the SCMS is used for lessons learned. Implementing CV infrastructure that is compliant with national standards that develop is important for achieving interoperability.

Develop plans for hiring and developing a workforce with the technical expertise to design, deploy, and maintain V2I equipment and to monitor and mitigate cybersecurity risks.

Take steps to ensure that privacy is protected.

## **Impact Assessment: Broadband Infrastructure**

### **Description**

Broadband infrastructure is an enabling technology for future connected vehicle applications, so technically, it is not a direct requirement to support automated driving. However it is an important supporting element for connected vehicle applications that will be beneficial for automated driving.

### **Certainty/potential time horizon**

There is lack of industry direction right now due to competing connected vehicle technologies, lack of regulatory requirements, and competition for the 5.9 GHz spectrum. Therefore, significant deployment of vehicle-to-vehicle and vehicle-to-infrastructure applications will continue to be pushed toward the future as some of these questions get resolved.

### **Co-benefits/advancing established goals**

Broadband infrastructure has other uses for Intelligent Transportation Systems (ITS) applications and connecting traffic signals. Installation of fiber optic cable to connect equipment offers benefits today along with preparing for future connected vehicle applications. This topic aligns with a current Governor's Office initiative to improve rural broadband access, so there may be opportunities for collaboration with that initiative.

### **Barriers**

The primary barrier to installation of broadband infrastructure along highway right-of-way is the added cost to projects. Other states have been able to leverage the value of access to highway right-of-way to get private investment to install fiber optic cable and provide some fiber strands for transportation use. In Oregon, state law provides utilities free access to right-of-way for installation of broadband infrastructure.

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<sup>77</sup> European Commission: Mobility and Transport. 2019. "Cooperative, Connected and Automated Mobility (CCAM)." Available at: [https://ec.europa.eu/transport/themes/its/c-its\\_en](https://ec.europa.eu/transport/themes/its/c-its_en)

## Impact to infrastructure owner/operator

Road operators should be developing plans for connecting ITS and traffic equipment. Where possible, this should be via fiber optic cable to prepare for future applications.

## Relevant national guidance/key decision makers

A federal executive order encourages use of highway right-of-way for shared use with telecommunications utilities. However, this is primarily a state and local issue. Decisions will be made locally about investment in broadband infrastructure or other communications methods as part of project scope.

## Next steps

Road operators should develop clear strategies, including identification of key routes and locations that will be most beneficial for broadband infrastructure. This should include looking at opportunities for partnerships and opportunities to collaborate with other initiatives, such as the Rural Broadband Initiative.

# Impact Assessment: Curb Space Management

## Description

By increasing demand for loading and unloading space and decreasing demand for parking, deployment of automated vehicles, especially in on-demand fleet applications, may necessitate changes to curb space management. Options for managing curbs to adapt to automated vehicles may include pricing, changes in zoning, reallocating curb space for different uses, geofencing curb spaces for certain activities, and the creation of dynamic curb spaces, which have different uses at different times.

## Certainty/potential time horizon

New technologies in transportation are already altering the demands on curb space. Transportation network companies (TNCs) and on-demand delivery services have increased the demand for loading and unloading areas to move both people and goods. Automated vehicles are expected to have similar effects as TNCs, since the first deployments of highly automated vehicles are likely to be in on-demand fleets.<sup>78</sup> While TNC drivers may stop in travel lanes or pick up passengers in areas not designed for that purpose, automated vehicles will be programmed to follow traffic laws and will need designated areas for passenger loading and unloading.<sup>79</sup> The effects of TNCs have already prompted cities and other jurisdictions to create new policies to manage their curb space.

## Co-benefits/advancing established goals

Managing curb space to accommodate automated vehicles has the potential to further a number of goals, such as:

- Improving the flow of traffic and safety by moving pickup and drop-off areas out of the busiest travel lanes, and encouraging mode shift by allocating more space to transit and increasing the price of parking.

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78 Fehr and Peers. October 19, 2018. "San Francisco Curb Study." Available at: [https://www.fehrandpeers.com/wp-content/uploads/2019/01/SF\\_Curb\\_Study\\_2018-10-19\\_web-download.pdf](https://www.fehrandpeers.com/wp-content/uploads/2019/01/SF_Curb_Study_2018-10-19_web-download.pdf)

79 Howell, Amanda, Nico Larco, Rebecca Lewis, and Becky Steckler. Urbanism Next Center, University of Oregon. March 2019. "New Mobility in the Right-of-Way." Available at: <https://urbanismnext.uoregon.edu/files/2019/03/Screen-Shot-2019-03-20-at-9.28.38-PM-1ca0x5i.png>

- Accommodating the efficient delivery of goods by providing access to loading and unloading space, especially in dense areas.
- Supporting transit and active transportation by making parking in city areas more limited and increasing the travel space available to transit services like buses and light rail.
- Reducing harmful emissions by discouraging idling and circling and promoting turnover in loading and unloading areas.
- Treating different users of the transportation system equitably by increasing the price of parking and using public space to the benefit of people other than car owners.

## Barriers

Creating systems to effectively manage curb spaces first requires a good understanding of an area’s curb space and its uses. Many infrastructure owner/operators do not have substantial or well-organized data about their curb spaces. Collecting this data, maintaining it and developing metrics to understand it will be a barrier. Private industry is addressing this gap by developing high definition map data. Some companies may provide access to this data as their business model, while others may collect data for their own purposes.<sup>80</sup> To dynamically manage curb spaces, jurisdictions may need to obtain and analyze mobile phone data or deploy sensors.<sup>81</sup>

The time horizon, impacts and deployment models for automated vehicles are uncertain. While TNCs are commonly used as a proxy for AV behavior, AV impacts on the use of curb space will not be known until there is deployment at scale. Without further information, it will be difficult for infrastructure owners/operators to change curbside management practices or make investment in infrastructure updates to address the impacts of AVs.

If the deployment of AVs increases loading and unloading activities, it could increase conflicts with bicyclists, who also travel alongside the curb and require safe and reliable access to that space. The needs of bicyclists must be considered when establishing new curb space management practices. Creating designated loading and unloading zones or building more separated bicycle lanes could help reduce this potential conflict.

## Impact to infrastructure owner/operator

Reallocating curb space could impact revenue, particularly in jurisdictions that rely heavily on parking revenue.<sup>82</sup> This lost revenue could be replaced by charging “curb-kiss” fees or other fees for vehicles using pickup and drop-off areas. For example, the District of Columbia has successfully implemented a paid permitting system to allow commercial vehicles access to loading zones at certain hours.<sup>83</sup>

## Relevant national guidance/key decision makers

This area will largely be shaped by policy decisions made by local jurisdictions. Professional organizations such as the National Association of City Transportation Officials and the Institute of Transportation Engineers have released studies and reports on this topic.

National guidance on vehicle to infrastructure communication protocol will be relevant for any efforts to use connected vehicle technology to administer dynamic curbside pricing.

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80 International Transport Forum. 2018. “The Shared-Use City: Managing the Curb.” Available at: <https://www.itf-oecd.org/shared-use-city-managing-curb-0>

81 Institute of Transportation Engineers. 2018. “Curbside Management Practitioners Guide.”

82 Ibid

83 Ibid

## Next steps

Examine state and city laws and regulations to understand the barriers to implementing new curbside management practices. Support efforts to gather and consolidate data about curbsides and their uses in local jurisdictions. Pursue data sharing agreements among public and private actors that possess data about curb space and the demands on it.

## Impact Assessment: Parking

### Description

It is possible that AVs will require less passenger vehicle parking than vehicles currently do. AVs may make it possible for travelers to send their vehicle back home or have it circle the block instead of finding and/or paying for a space in locations where parking is limited. It may be possible to park more vehicles using less space if AVs are able to navigate themselves into tighter spaces than human drivers. If AVs are operated in shared fleets, individual vehicle ownership could fall dramatically, significantly reducing the need for parking.

### Certainty/potential time horizon

It is not clear whether or how much AVs will reduce the demand for parking, nor when these impacts will occur. Some of the factors creating uncertainty include:

- AV deployment models: Much of the AV industry is focused on a shared-fleet deployment model that could reduce AV parking needs; ride-hailing services see the potential for AVs to cut the cost of service by eliminating labor costs, and AV companies such as Waymo are testing their AVs in shared service. However, it remains to be seen whether ride-hailing companies can successfully transition to a model where they own and operate large numbers of vehicles.
- Response to shared services: Even if AVs are deployed in a shared-fleet model, it remains to be seen whether this model can succeed in the U.S. given the country's dispersed land-use patterns and long history of car ownership. Ride-hailing services, which essentially function as shared AVs with human drivers, have not yet produced a clear and significant impact on car ownership or parking demand. Lyft reported that 250,000 of its roughly 23 million users gave up a car in 2017,<sup>84</sup> but independent research has found that car ownership continues to grow in spite of ride-hailing, and that ride-hailing competes with public transportation more than it does with personal vehicles, which means that it could actually increase car ownership and parking demand.<sup>85</sup>
- AV policies: If AVs circle or return home empty instead of parking at their destination, it would significantly increase congestion and pollution. The public may want to manage or price AVs in a way that limits empty driving, which would limit one of the pathways by which AVs could reduce parking. Without changes to curbside management practices, AV companies may also use public parking in busy downtowns as staging areas to be conveniently located for potential customers.
- AV capability: The extent to which AVs allow for more space-efficient parking depends upon how accurately AVs are able to navigate.

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84 Etherington, Darrell. TechCrunch. January 16, 2018. "Lyft says nearly 250K of its passengers ditched a personal car in 2017." Available at: <https://techcrunch.com/2018/01/16/lyft-says-nearly-250k-of-its-passengers-ditched-a-personal-car-in-2017/>

85 Schaller, Bruce. Schaller Consulting. July 25, 2018. "The New Automobility: Lyft, Uber and the Future of American Cities." Available at: <http://www.schallerconsult.com/rideservices/automobility.pdf>

The impacts of AVs on parking will become apparent in high-demand locations when there are significant numbers of AVs on the road, and in other locations when the majority of vehicles on the road will be automated. Projections on AV adoption vary, but it seems likely that it will be 15 to 20 years before there are significant numbers of AVs on the road and at least 35 years until the majority of cars on the road are AVs,<sup>86</sup> potentially later, given that many manufacturers and experts have been dialing back expectations around AV technology development.<sup>87</sup> However, the built environment is slow to change, and parking spaces that are being built today could last for 50 years. Even if AVs make it possible to reduce parking, it could be a long time before communities capitalize on the opportunity.

## Co-benefits/advancing established goals

Though it is too early to tell exactly how much AVs will enable communities to reduce parking, there is a growing consensus that there is an overabundance of free and cheap parking in U.S. urban areas.<sup>88</sup> Changing parking policies and prices today would support several of Oregon's policy goals, including those that call for the state to support a variety of transportation modes (Statewide Planning Goal 12, Transportation Plan Goal 1), create sustainable communities (Statewide Planning Goal 13, Transportation Plan Goal 4), and create a variety of housing types (Statewide Planning Goal 10).

Research has shown that creating compact communities, especially in urban centers and along major transportation corridors, is critical to meeting these goals,<sup>89</sup> and that reducing the amount and price of parking is critical to creating compact communities. Several of these goals explicitly mention the importance of increasing land use density in key locations. Denser communities create more opportunities for people to walk, bike, or take transit instead of driving; take shorter trips when they do drive; and live in a wider variety of housing types at a variety of price points. Local governments often require more parking than is needed, which makes it harder to develop dense communities because it creates more space for cars instead of people and drives up the cost of development. The resulting oversupply of cheap parking also encourages people to drive even when other options are available.

Furthermore, research on ride-hailing has found that one of the main reasons that people use ride-hailing is because parking at their destination is expensive or limited.<sup>90</sup> This suggests that implementing parking reform today instead of waiting for AVs to enable parking reform tomorrow could help to steer AVs toward a shared-fleet model that would better support Oregon's policy goals.

## Barriers

Barriers to parking policy reform include the lack of transportation options in many communities. Unless people have other travel choices besides driving, increasing the cost or reducing the supply of parking may penalize drivers while failing to produce some of the benefits discussed above. The methods that are typically used to set parking requirements do not account for the extensive body of research showing how compact communities with good transportation options reduce the need for parking.

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86 Litman, Todd. Victoria Transport Policy Institute. March 18, 2019. "Autonomous Vehicle Implementation Predictions: Implications for Transport Planning." Available at: <https://www.vtppi.org/avip.pdf>

87 For example, see: <https://www.autonews.com/mobility-report/uber-sees-some-time-avs-dominate-road>

88 UCLA professor Donald Shoup has extensively documented the oversupply of parking and the potential of different parking reform policies. See: <https://www.shoupdogg.com/publications/>.

89 For a synthesis of the exhaustive literature linking dense, mixed-use communities to reductions in driving and increased use of other modes, see: <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.710.1517&rep=rep1&type=pdf>.

90 For a summary of the research, see: <http://www.schallerconsult.com/rideservices/automobility.pdf>.

## Impact to infrastructure owner/operator

Best-practice parking policy reforms typically increase revenues for infrastructure owner/operators. Increasing the cost of parking raises more revenue for agencies that manage parking infrastructure, and reducing parking supply or requirements typically enables higher-value development that contributes more tax revenue. There can be short-term costs associated with revising policies, redesigning streets, and installing new parking meters, but the long-term increase in revenue often allows agencies to recoup these costs relatively quickly.

## Relevant national guidance/key decision makers

The Institute of Transportation Engineers' (ITE) *Parking Generation Manual*<sup>91</sup> is widely used to set parking requirements, but critics have argued that ITE does not account for the extensive body of research showing how compact communities with good transportation options reduce the need for parking, leading it to overestimate parking demand in these locations.<sup>92</sup> Some agencies have adopted alternative methods to better estimate parking demand in urban areas.<sup>93</sup>

Developers, the lenders who finance them, and financial regulatory bodies all play an important role in implementing reduced parking requirements. Even where public policies encourage or require developers to provide less parking, lenders who look across their portfolios at average parking provision may view developments that meet these requirements as risky bets. Any extensive parking policy reform effort should include consultation with developers and lenders to ensure that the proposed changes are feasible to implement.

## Next steps

AVs may or may not decrease parking demand, but there is plenty of evidence that many cities already have an oversupply of parking, and that reforming parking policy would help to achieve Oregon's policy goals. Local governments have authority over parking policies, and many are pursuing best practices, including reducing or removing minimum parking requirements, increasing or managing the cost of public parking, and allowing for the shared use of existing parking rather than creation of new parking. State and regional governments can enact policies, issue guidance, and provide resources and tools to help implement this guidance. In particular, we recommend that the state strengthen existing policies and programs that support local parking policy reform, including:

- Strengthening the current requirement in the Transportation Planning Rule that local governments in metropolitan planning organization (MPO) areas implement parking plans that achieve a 10 percent reduction in the number of parking spaces per capita.
- Requiring that planning projects funded by the state Transportation and Growth Management (TGM) program address best practices that reduce the oversupply of parking. The TGM program has already funded development of several local parking policies, but grants do not require approaches to address parking reform.
- Promoting parking cash-out programs, which allow employees to opt to receive cash instead of a parking space at work.

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91 Hooper, Kevin G. The Institute of Transportation Engineers. February 2019. "Parking Generation Manual." Available at: <https://www.ite.org/technical-resources/topics/trip-and-parking-generation/>

92 For an overview of the concerns with ITE's approach, see: <http://shoup.boi.ucla.edu/TruthInTransportationPlanning.pdf>. For an example of how ITE overestimates parking needs in urban settings, see: [https://nelsonnygaard.com/wp-content/uploads/2014/04/2014-01\\_Urban-Trip-Generation-Final-Report.pdf](https://nelsonnygaard.com/wp-content/uploads/2014/04/2014-01_Urban-Trip-Generation-Final-Report.pdf).

93 For example, EPA has funded research and produced a tool to adjust parking demand estimates in compact, mixed-use areas (<https://www.epa.gov/smartgrowth/mixed-use-trip-generation-model>) and agencies like the City of Los Angeles ([https://ladot.lacity.org/sites/g/files/wph266/f/VMT\\_Calculator\\_Documentation\\_20190228.pdf](https://ladot.lacity.org/sites/g/files/wph266/f/VMT_Calculator_Documentation_20190228.pdf)) have promoted the use of EPA's methods in development review.

State, regional and local governments can also take action to manage and price the transportation system in a way that encourages people to share vehicles, increasing the likelihood that AVs will be deployed in a model that supports the state's land use and transportation goals. Several agencies in Oregon, including ODOT, Metro, and the City of Portland, are exploring pricing as a way to manage congestion and demand for driving. We recommend that agencies explore ways of implementing pricing that enable them to set higher prices for drive-alone (and in the future, zero-occupant) trips and trips in compact communities that already have good travel options. The State should also prioritize any AV funding or incentives for automated transit and shared AVs.

## Impact Assessment: Lane Width

### Description

AVs could navigate more accurately than human drivers, which would mean that they could potentially travel in narrower lanes than human-driven vehicles currently do. We focus on narrowing lanes on highways and arterials, which currently have wider lanes than other streets to accommodate higher speeds, and present opportunities to narrow lanes under AVs.

### Certainty/potential time horizon

Significantly reducing lane widths for passenger vehicles may be feasible when the majority of vehicles on the road are AVs that are proven to be able to navigate significantly more accurately than human drivers. It is not clear when the majority of vehicles on the road will be automated, but even according to more optimistic projections the majority of cars will be human-driven for the next several decades, and in the past year many manufacturers and experts have been further dialing back expectations of imminent Level 5 automation. Based on the limited AV testing being conducted today, it is not clear when, if ever, AVs will be capable of navigating roadways more accurately than human drivers – especially in adverse weather or difficult conditions.

### Co-benefits/advancing established goals

Narrowing lane widths for passenger vehicles would support a variety of existing policy goals:

- Oregon's statewide planning goals call for the state to support a variety of transportation modes (Goal 12), yet Oregonians still drive for most trips. Narrowing lanes could allow the state to create more space for transit and active transportation, making these modes safer and more convenient.
- Goal 2 of the Oregon Transportation Plan calls for the state to improve the efficiency of the transportation system. Narrowing lanes could free up more space to create an extra lane and increase roadway capacity within the existing right of way.
- Goal 5 of the Oregon Transportation Plan calls for the state to ensure that the transportation system is safe for all users. Research suggests that the 12-foot travel lanes that are standard on many highways and arterials encourage drivers to speed, and that narrowing lane widths on arterials reduces speeds without significantly reducing capacity or creating additional safety risks.<sup>94</sup> Therefore, narrowing travel lanes on certain arterials from 12 to 10 feet could produce immediate safety benefits even before AVs arrive, and AVs could then provide the potential to free up even more space in the roadway.

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94 For a summary of the relationship between lane widths and travel speeds, including citations of relevant research, see <https://nacto.org/publication/urban-street-design-guide/street-design-elements/lane-width>. FHWA acknowledges the relationship between lane widths and vehicle speeds, and recommends reduced lane widths as a strategy to improve safety in reduced-speed urban environments: [https://safety.fhwa.dot.gov/geometric/pubs/mitigationstrategies/chapter3/3\\_lanewidth.cfm](https://safety.fhwa.dot.gov/geometric/pubs/mitigationstrategies/chapter3/3_lanewidth.cfm).

## Barriers

Opportunities to reduce lane widths can be limited when roads serve multiple purposes. For example, passenger vehicles often share roadway space with commercial, freight and emergency vehicles that are typically wider than passenger vehicles and require wider lanes. A state highway that connects two different cities may become a main street for one of these cities. It is important to consider all road users and purposes before narrowing lanes.

Looking ahead, additional barriers to changing passenger vehicle lane widths are the high uncertainty (see above), high costs (see below), and potential lack of data. Data on AV volumes and travel patterns is essential to determining when and where infrastructure owners can narrow lanes and how they might redesign roads. Many proposed state and federal AV policies have not provided for the sharing of this data with infrastructure owners.

## Impact to infrastructure owner/operator

According to one DOT, restriping costs run roughly \$1.14-1.37 per linear foot, or \$12,000-14,500 per lane-mile.<sup>95</sup> However, restriping is less expensive than widening a roadway, so restriping can save infrastructure owners money if it enables more lanes to fit in the same overall right of way. In addition, if automated vehicles waver less within the narrowed lanes, it could increase rutting, which would also increase maintenance costs over time.

## Relevant national guidance/key decision makers

AASHTO's *Policy on Geometric Design of Highways and Streets* ("The Green Book")<sup>96</sup> is the set of roadway design standards most commonly used by infrastructure owners, particularly state and county agencies. The Green Book currently allows for lane widths as low as 10 feet on arterial streets, but would need to be amended (or states would need to adopt separate design guidance) to allow for lanes narrower than 10 feet. The NACTO Urban Street Design Guide,<sup>97</sup> which is used in lieu of the Green Book in many larger cities, calls more explicitly for lanes to be narrower wherever feasible.

## Next steps

Due to the fact that AV technology is still developing and the many different uses that many roadways serve, it will likely be several decades before infrastructure owners can begin to consider narrowing roadways to take advantage of AVs. Potential next steps include:

- Creating guidance describing the conditions (AV saturation, maturity) under which the state may want to consider restriping AV lanes.
- Adopting policies governing reallocation of new space created by AVs.

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95 Virginia Department of Transportation. "Fairfax County Parkway and Franconia-Springfield Parkway Corridor Study: Appendix L – Planning Level Cost Estimates." Available at: [http://www.virginiadot.org/projects/resources/NorthernVirginia/AppendixL\\_PlanningLevelCostEstimate.pdf](http://www.virginiadot.org/projects/resources/NorthernVirginia/AppendixL_PlanningLevelCostEstimate.pdf)

96 Association of American Highway Transportation Officials. 2018. "A Policy on Geometric Design of Highways and Streets, 7th Edition."

97 National Association of City Transportation Officials. "Urban Street Design Guide." Available at: <https://nacto.org/publication/urban-street-design-guide/>

# Impact Assessment: Electric Vehicle Charging Infrastructure

## Description

Electric vehicle charging infrastructure provides opportunities to charge electric vehicles. Charging is generally categorized by location (home, workplace, and public) and level, which indicates the voltage of the charger and therefore the speed with which a vehicle can charge (Level 1 is a standard 120V wall outlet; Level 2 is a 240V outlet of the type commonly used for residential dryers; Level 3 is a 480V charger developed specially for EVs). Homes and workplaces see higher demand for charging than public locations, and typically need lower levels of charging because vehicles are parked longer in these locations. Most AVs currently being developed are EVs, and many anticipate that deployment of AVs will increase the demand for EV charging.

## Certainty/potential time horizon

Most AVs currently under development are EVs because EV drivetrains work better with AV control systems. However, it remains to be seen whether this will remain true as AVs continue to develop. The market for conventional-fuel vehicles is much larger than the market for EVs, which may drive AV manufacturers to move into developing conventional-fuel vehicles.

Regardless of how AVs develop, the number of electric vehicles on the road is expected to increase significantly over the coming decades thanks to falling battery prices and increased ranges that make electric vehicles more useful. Some forecasts anticipate rapid growth in EV technology and usage over the coming decade. One analysis estimates that EVs, which are now significantly more expensive than comparable conventional-fuel vehicles, will cost the same as conventional vehicles by 2022.<sup>98</sup> Another analysis estimates that the average range of EVs will double between now and 2028.<sup>99</sup>

These changes mean more EVs on the road, but they also call into question the value of some of the strategies that public agencies have traditionally used to support vehicle electrification. The subsidies that state and federal agencies offer EV buyers may no longer be necessary if the cost of EVs falls, and the public charging infrastructure that agencies often provide may not be needed if the range of EVs increases – or may fall out of date if even faster chargers are needed to support higher-range EVs.

The question of whether public agencies should provide EV charging to prepare for AV deployment is complicated by the fact that AVs could be deployed in shared fleets rather than being individually owned. If so, it may be more appropriate for fleet operators to invest in EV charging infrastructure rather than for public agencies to make investments that primarily benefit private companies.

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98 Bullard, Nathaniel. *Bloomberg*. April 12, 2019. "Electric Car Price Tag Shrinks Along with Battery Cost." Available at: <https://www.bloomberg.com/opinion/articles/2019-04-12/electric-vehicle-battery-shrinks-and-so-does-the-total-cost>

99 McDonald, Loren. *CleanTechnica*. October 27, 2018. "US Electric Car Range Will Average 275 Miles By 2022, 400 Miles by 2028—New Research (Part 1)." Available at: <https://cleantechnica.com/2018/10/27/us-electric-car-range-will-average-275-miles-by-2022-400-miles-by-2028-new-research-part-1/>

## Co-benefits/advancing established goals

Providing EV charging could help to meet Oregon's climate goals as established in House Bill 3543,<sup>100</sup> as well as Executive Order 17-21,<sup>101</sup> which calls on the state to significantly increase the number of EVs on the road. However, there is no conclusive evidence that providing increased access to charging outside the home makes a meaningful difference in increasing the number of EVs on the road.

## Barriers

The main barriers to public investments in EV charging are high uncertainty (see above) and high costs (see below). In addition, several agencies in Oregon have been adopting more aggressive policies to make equity a guiding factor in transportation investments. This can make it harder to justify investment in EV charging since the EV owners are wealthier than average.<sup>102</sup>

## Impact to infrastructure owner/operator

The cost of installing EV charging varies widely depending upon the location, site characteristics, and existing electrical infrastructure. Many residents can plug their EV into an existing garage outlet for free, whereas Level 2 chargers cost \$6,000-9,000 per charger and Level 3 chargers cost \$100,000-150,000 per charger, with costs tending toward the higher end of the range for public installations, which often involve complex sites without existing electrical infrastructure. Maintenance costs range from \$300-2,000 per year.<sup>103</sup> Private companies typically operate charging stations at no additional costs to public agencies. There are currently no estimates of statewide EV charger needs for Oregon, which means that we cannot estimate the total costs of providing charging in the state.

## Relevant national guidance/key decision makers

N/A

## Next steps

Potential next steps include:

- Amend the state building code to further require that new developments include charging or pre-wire parking areas, which greatly reduces the cost of installing EV chargers in the future. The building code requires pre-wiring five percent of spaces in new parking facilities in Oregon's largest cities for EV charging,<sup>104</sup> and Executive Order 17-21 requires that the building code be amended by 2022 to require pre-wiring of at least one space in all new residential and commercial buildings, but there may be opportunities to further increase these requirements if projected demand for EVs increases.
- Conduct an analysis of statewide EV charging needs, including under different AV deployment scenarios.

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100 Oregon Legislative Assembly – 2007 Regular Session. "Enrolled House Bill 3543." Available at: <https://olis.leg.state.or.us/liz/2007R1/Downloads/MeasureDocument/HB3543>

101 State of Oregon, Office of the Governor. "Executive Order No. 17-21." Available at: [https://www.oregon.gov/gov/Documents/executive\\_orders/eo\\_17-21.pdf](https://www.oregon.gov/gov/Documents/executive_orders/eo_17-21.pdf)

102 Woodyard, Chris. USA Today. May 4, 2015. "Study: Electric car buyers are younger but richer." Available at: <https://www.usatoday.com/story/money/cars/2015/05/04/truecar-study-electric-cars-richer/26884511/>

103 Agenbroad, Josh and Ben Holland. GreenBiz. May 8, 2014. "RMI: What's the true cost of EV charging stations?" Available at: <https://www.greenbiz.com/blog/2014/05/07/rmi-whats-true-cost-ev-charging-stations>

104 Oregon Administration Rules. "OAR 918-020-0380: Building Codes Division: Delegation of Programs of Local Jurisdictions." Available at: [https://secure.sos.state.or.us/oard/viewSingleRule.action;JSESSIONID\\_OARD=Xq-Xbj0797wOpb\\_J6CgYVS-0PCESzufOx-11-sILsE1sMPUoYlw!1747720130?ruleVrsnRsn=226334](https://secure.sos.state.or.us/oard/viewSingleRule.action;JSESSIONID_OARD=Xq-Xbj0797wOpb_J6CgYVS-0PCESzufOx-11-sILsE1sMPUoYlw!1747720130?ruleVrsnRsn=226334)

- Dedicate additional funding, such as VW settlement funds or cap-and-invest revenues, to EV charging.
- Continue or expand existing state EV charging initiatives, such as the West Coast Electric Highway.
- Examine the impacts of increased EV adoption on electrical infrastructure to ensure that Oregon's power grid is able to accommodate an increased number of EVs.
- Continue to monitor adoption of EVs and other alternative-fueled vehicles.

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# Land Use

## Scope of the Materials and Recommendations

This section of the report contains materials prepared by the Subcommittee on Land Use and approved by the full Task Force on Autonomous Vehicles. The subcommittee outlined how other jurisdictions are preparing for the potential impacts of automated vehicles, looking specifically at data management, land use planning, greenhouse gas reduction, and pricing strategies. The subcommittee also provided information on occupancy pricing and how it could potentially apply to automated vehicles. Finally, the subcommittee recommended that Oregon's AV work further existing state goals.

## Examples from Other Jurisdictions

### Introduction

Because there is little national guidance on automated vehicles and land use policy, members of the Subcommittee on Land Use instead researched examples of land use planning and projects undertaken by cities to prepare for the deployment of automated vehicles. Subcommittee members were asked to focus their research on three specific aspects of a city's AV planning: 1) data needs, 2) land use planning and greenhouse gas reduction goals, and 3) pricing (including road and curb pricing). This document summarizes that research.

The cities below represent a sampling from across the U.S. and the world. This document is not meant to be comprehensive. For a more complete list of cities that are preparing for automated vehicles, see Bloomberg's "Initiative on Cities and Autonomous Vehicles," which includes a global atlas.<sup>105</sup>

### Austin, Texas

#### Background

The state of Texas has passed an AV law that preempts local regulation of automated motor vehicles and automated driving systems. The law specifies that the owner of an automated driving system is the operator of the vehicle when the system is engaged and the system is considered licensed to operate the vehicle. It allows an automated motor vehicle to operate in the state regardless of whether a human operator is present in the vehicle, as long as certain requirements are met.

Waymo has been testing automated vehicles in Austin since 2015, when it had its first truly driverless ride in Northeast Austin. In addition, Cap Metro, Austin's transit agency, is testing 6-8 minibus-style automated vehicles with an operator on board. Mayor Steve Adler said, "Austin should be to automated vehicles what Detroit was to the last century of automakers."

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<sup>105</sup> Bloomberg Philanthropies and the Aspen Group. 2019. "Initiative on Cities and Autonomous Vehicles." Available at: <https://avsincities.bloomberg.org/global-atlas/>

## Data

The city partnered with INRIX in 2018 on a platform that will let the city identify traffic rules and obstructions on a road-by-road basis and then share that data with autonomous vehicle providers.<sup>106</sup> This digitizes local rules, such as speed limits, school zones and stop signs for automated vehicles.

The Riverside Corridor is the first site in the country to roll out connected vehicle reference implementation architecture (CVRIA) signal controllers.<sup>107</sup> These are standards the US DOT has established for how intersections communicate with vehicles.

## Planning

In February 2019, Austin released its Draft Strategic Mobility Plan. While the plan does not specifically address automated vehicles, it sets goals that could be affected by the deployment of automated vehicles, including sustainability indicators and targets and land use indicators and targets.

## Pricing

Austin's Draft Strategic Mobility Plan also discusses pricing, including curb management. While it does not specifically address automated vehicles, it raises issues that would be relevant at the deployment stage:

"Parking management could incorporate innovative curb management techniques to help reduce congestion, such as technology that alerts drivers to available spaces so they are not adding to traffic by circling in search of parking spaces. Properly pricing public parking at market rate could also help ease congestion by evenly distributing the demand across the parking system and making other travel choices attractive to more users. Flexible curb use could also enhance mobility by allowing various purposes for parking spaces during different hours of the day, such as valet parking, ride-hail pickup and drop-off locations, or as public spaces such as parklets."

In addition, the University of Texas at Austin conducted a study on automated vehicles and congestion pricing, "Congestion Pricing in a World of Self-Driving Vehicles: An Analysis of Different Strategies in Alternative Future Scenarios."<sup>108</sup> According to the university, "This work develops multiple CP and tolling strategies in alternative future scenarios, and investigates their effects on the Austin, Texas network conditions and traveler welfare, using the agent-based simulation model MATSim. Results suggest that, while all pricing strategies reduce congestion, their social welfare impacts differ in meaningful ways. More complex and advanced strategies perform better in terms of traffic conditions and traveler welfare, depending on the development of the mobility landscape of autonomous driving. The possibility to refund users by reinvesting toll revenues as traveler budgets plays a salient role in the overall efficiency of each CP strategy as well as in the public acceptability."

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106 Inrix. 2019. "Inrix Road Rules." Available at: <http://inrix.com/products/road-rules>

107 U.S. Department of Transportation, Intelligent Transportation Systems Joint Program Office. "ITS Standards Program: Development Activities for Connected Vehicle Reference Implementation Architecture (CVRIA)." Available at: <https://www.standards.its.dot.gov/developmentactivities/cvreference>

108 Simoni, Michele D., Kara M. Kockelman, Krisha M. Gurumurthy, Joschka Bischoff. University of Texas at Austin. 2018., "Congestion Pricing in a World of Self-Driving Vehicles: An Analysis of Different Strategies in Alternative Future Scenarios." Available at: <https://arxiv.org/pdf/1803.10872.pdf>

## Lincoln, Nebraska

### Background

Nebraska passed statewide legislation authorizing the use of automated driving systems and driverless-capable vehicles. With a federal exemption, automated driving system-equipped vehicles may operate on any road in the state with or without a conventional driver physically present in the vehicle. If a conventional driver is present, they are required to hold a valid operator's license. The vehicle must follow all the rules of the road. Automated vehicles may also be used for network transportation, including ride-sharing and public transportation. In the event of a crash or collision, the automated driving system-equipped vehicle is required to stay at the scene of the incident and comply with existing laws for motor vehicle crashes. Nebraska law also includes a provision that clearly states that no state or any political subdivision is required to plan, design, construct, maintain, or modify any road for the accommodation of automated vehicles.

In 2018, more than 1,500 riders participated in the test of a Navya shuttle at Nebraska Innovation Campus. It was like an "autonomous vehicle Uber-pool," simulating the experience of calling a vehicle through an app, engaging residents along the way to identify best pickup and drop-off spots and key application features. General response was positive. The goals of the project included:

- Easing traffic congestion and preserving air quality in response to a growing population.
- Providing safe and efficient transportation systems for Lincoln residents and visitors.
- Accommodating evolving rider needs and new technologies in StarTran's strategic plan.
- Attracting new businesses, residents and visitors to Lincoln and Nebraska.

The team intends a broader rollout, which they hope might help more seniors and others living downtown, but are still pursuing alternative funding.

### Planning

Lincoln has not incorporated automated vehicles into their planning documents, but the energy and land use goals identified in the Lincoln Environmental Action Plan could be relevant for electric automated vehicles. Goals include reducing per capita greenhouse gas emissions, increasing the use of renewable energy, and maintaining and increasing greenways.

## Ann Arbor, Michigan

### Background

Ann Arbor's approach to autonomous vehicles is twofold. The University of Michigan has built a 32-acre ghost town (Mcity) for the purpose of testing AVs. It provides a controlled environment to test cybersecurity, driver engagement, vehicle-driver transitions, and other aspects of how people interact with AVs.<sup>109</sup> The university also explored the deployment of up to 50 on-demand shuttles on its campus, operating on university-controlled roads, outside the confines of Mcity.<sup>110</sup> Additionally, Ford Motor Company and Domino's Pizza are simulating how people might interact with AV-enabled services through a month-long pizza delivery test using AV-capable vehicles accompanied by a human safety engineer in the driver's seat.

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109 Pradhan, Anuj and Shan Bao. Mcity. May 5, 2015. "Examination of Operator State Monitoring and Operator Engagement as Strategies for Mitigating Human Factors." Available at: <https://mcity.umich.edu/research/examination-of-operator-state-monitoring-and-operator-engagement-as-strategies-for-mitigating-human-factors-challenges-associated-with-transfer-of-control-during-automated-driving/>

110 Mcity. 2019. "Mcity Driverless Shuttle: A Case Study." Available at: <https://mcity.umich.edu/wp-content/uploads/2018/09/mcity-driverless-shuttle-case-study.pdf>

## Planning

One report, the *Road Map of Autonomous Vehicle Service Deployment Priorities in Ann Arbor*, assessed the opportunities for AV deployment within Ann Arbor.<sup>111</sup> The approach used a travel demand analysis to determine the number of trips between zones of interest and estimated the number of trips taken via public transportation in order to develop a “demand profile.” They found that private, single-passenger AV use does not offer substantial improvements in energy consumption or congestion. They also concluded that more convenient travel may stimulate more frequent/longer trips.

The report also looked at vehicle characteristics required to provide a given autonomous mobility service in an increasingly sustainable and equitable manner. The report notes that shared AVs, because they will be subject to heavier use, can improve transportation sustainability by having shorter lifespans, allowing newer, more efficient vehicles to take their place. While rapid replacement seems counterintuitive, a large majority of a vehicle’s life cycle energy consumption occurs during the use phase (burning fuel). Ride-sharing can lead to further improvements in sustainability performance by removing vehicles from the road, but there needs to be a balance between sharing rides and efficiently routing trips to minimize riders’ distance and time traveled. If ride-sharing becomes too inconvenient due to longer trips, rider participation will be low. The report recommends prioritizing shared AV deployment to “most efficiently utilize transportation resources and enhance sustainability.”

“Adjusting the mode supplying transit service according to demand will result in higher return on investment and a more self-sustaining business. Alternatively, novel transit modes can be introduced that provide a new service or support existing modes (e.g., last-mile) that may tap into latent demand for travel.”<sup>112</sup>

The report concludes that AV deployment on public roadways should occur in a controlled manner within environments that are prepared for and which can safely accommodate unmanned vehicles. “When AVs move outside of designated testing centers such as Mcity, permissible roadways must be explicitly defined and enforced.”<sup>113</sup> “From serving single origin-destination trips, deployment can then be expanded to confined areas where any origin/destination can be served as long as the AV remains in the permitted area. This sort of service could occur within a shopping or downtown center, or at events such as concerts or sports games, where demand analysis shows high intra-zonal flows.”<sup>114</sup>

## Tokyo, Japan

### Background

The Japanese government is aspiring to have AV fleets available in time for the 2020 Olympic Games.<sup>115</sup> AVs provide an opportunity to address challenges posed by Tokyo’s growth and aging population. Japanese automotive-tech houses began 3-D mapping the country’s roadways to get them ready for autonomous vehicles. In 2018, a self-driving taxi was deployed in Tokyo as a part of the pilot.

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111 Keoleian, Gregory A., Lidia P. Kostyniuk, Tulga Ersal, Cory Wydysh, Geoffrey Lewis, and Jeffrey L. Stein. Mcity., September 30, 2016. “Report No. CSS16-21: Road Map of Autonomous Vehicle Service Deployment Priorities in Ann Arbor.” Available at: <http://css.umich.edu/sites/default/files/publication/CSS16-21.pdf>

112 Ibid, pg. 45.

113 Ibid, 2016, pg.p 47.

114 Ibid, 2016, pg. 47.

115 Burns, Janet. *Forbes*. Sept. 8, 2016. “Japan’s Leaders Want To Make Tokyo A Self-Driving City For 2020 Olympics.” Available at: <https://www.forbes.com/sites/janetwburns/2016/09/08/japanese-leaders-aim-to-make-tokyo-a-self-driving-city-for-2020-olympics/#1673e3cf1090>

## Planning

While there is information regarding the efforts to ensure the cybersecurity of AVs and the technological development of the AVs themselves, there is little information regarding the land use planning aspects of the push.<sup>116</sup> In part this may have to do with the fact that in Tokyo, in particular, individuals are used to public transportation because it is expensive and difficult to own a car in the city. A project conceptualization document identifies urban and rural infrastructure concerns and priorities.<sup>117</sup> Additional information is available on the SIP-adus site: <http://en.sip-adus.go.jp/topics/>

## Tallinn, Estonia

### Background

Tallinn is the capitol of Estonia and is home to the Tallinn University of Technology. The city has done a fair amount of work to prepare for the deployment of automated vehicles, including efforts to draw technology companies to Estonia.

Estonia is home to Starship Technologies, which has developed local delivery robots. The delivery robots have been trialed extensively in Tallinn, delivering goods to downtown businesses and to suburban residents. The trial results are promising, but interaction between the delivery robots and pedestrians presents challenges. Possible next steps include using a “mothership,” a large delivery truck parked near downtown and from which the robots travel a few hundred yards to deliver goods.<sup>118</sup>

Tallinn also tested small automated buses in August 2017. Public reaction was generally positive and there were no major safety incidents.<sup>119</sup>

### Planning, Pricing and Data

Tallinn has a regulatory framework for the delivery robots, but no information was available on efforts in Tallinn to address automated vehicles and planning, pricing or data.<sup>120</sup>

## Pittsburgh, Pennsylvania

### Background

Pittsburgh has been home to significant automated vehicle testing activity. Carnegie Mellon University has been on the cutting edge of automated vehicle research and development. In addition, Uber and a handful of other companies have tested automated vehicles in the city, although testing was temporarily halted after the fatal Uber crash in Arizona.

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116 *Reuters*. June 15, 2017. “Tokyo Taxi Firm Teams With This Robotics Maker to Have Self-Driving Cabs for 2020 Olympics.” Available at: <http://fortune.com/2017/06/15/tokyo-2020-olympics-self-driving-cars/>

117 “Implementing the ART (Advanced Rapid Transit) system to meet the challenges caused by Tokyo’s further growth and aging population.” Available at: [http://www8.cao.go.jp/cstp/tyousakai/olyparatf/project/pj8\\_en.pdf](http://www8.cao.go.jp/cstp/tyousakai/olyparatf/project/pj8_en.pdf) [https://www8.cao.go.jp/cstp/tyousakai/olyparatf/project/pj4\\_en.pdf](https://www8.cao.go.jp/cstp/tyousakai/olyparatf/project/pj4_en.pdf)

118 Tallinn Transport Department and Freight Tails. April 2018. “The Future of Transportation in Tallinn, Estonia.” Available at: [https://urbact.eu/sites/default/files/media/freight\\_tails\\_case\\_study\\_the\\_future\\_of\\_transportation\\_in\\_tallinn\\_estonia\\_april\\_2018\\_0.pdf](https://urbact.eu/sites/default/files/media/freight_tails_case_study_the_future_of_transportation_in_tallinn_estonia_april_2018_0.pdf)

119 Postimees. August 28, 2017. “Driverless buses traveled 1,300 km in month in Tallinn.” Available at: <https://news.postimees.ee/4224601/driverless-buses-traveled-1-300-km-in-month-in-tallinn>

120 Hoffmann, Thomas and Gunnar Prause. MDPI. August 1, 2018. “On the Regulatory Framework for Last-Mile Delivery Robots.” Available at: <https://www.mdpi.com/2075-1702/6/3/33/pdf>

## Planning

The Pennsylvania Department of Transportation has been relatively open to automated vehicle testing, as has the city of Pittsburgh. In March, the mayor published the Pittsburgh Shared and Autonomous Mobility Principles, which lays out the city's goals,<sup>121</sup> including:

- Supporting city and street design that prioritizes people and human safety
- Enhancing access and connectivity for all residents across both city and region
- Ensuring equitable service across geography, socio-economic groups, and time
- Protecting public mobility and mass transit as the most accountable, transparent and sustainable mobility option
- Promoting shared, higher-occupancy vehicles for people and freight
- Promoting and enabling land development patterns that locate everyday destinations and needs in close proximity to people
- Integrating mobility systems for seamless travel and access

## Data

Other goals outlined in the Pittsburgh Principles address data issues, including the goal of “increasing open and shared data while protecting civil liberties and individual and system security.”<sup>122</sup>

## San Jose, California

### Background

California has passed some of the most detailed laws regarding automated vehicle testing and deployment in the U.S. Over sixty companies have applied for and received permission to test automated vehicles on public roads in California, and testing is ongoing in several locations throughout the state.

Several companies are testing automated vehicles in San Jose, including General Motors and Waymo.

### Planning and Data

In 2017, San Jose issued a Request for Information about pilots for automated vehicle technology. San Jose was “most interested in understanding how autonomous vehicles could advance” various city goals, including reducing the environmental impact of vehicle miles traveled, creating a more livable and walkable city, and sharing and utilizing data to optimize the transportation system and protect residents’ privacy.<sup>123</sup>

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121 Murray, Ashley. *Pittsburgh Post-Gazette*. March 4, 2019. “Mayor Peduto, self-driving car companies announce ‘Pittsburgh Principles.’” Available at: <https://www.post-gazette.com/local/city/2019/03/04/Mayor-Peduto-self-driving-car-companies-announce-Pittsburgh-Principles/stories/201903040058>

122 City of Pittsburgh, Office of the Mayor. March 4, 2019. “Pittsburgh Shared and Autonomous Mobility Principles.” Available at: <http://pittsburghpa.gov/domi/autonomous-vehicles>

123 City of San Jose. June 1, 2017. “Request for Information: Pilot for Autonomous Vehicle Technology.” Available at: <https://moti.sanjosemayor.org/wp-content/uploads/2018/10/AV-RFI-SJ.pdf>

## Seattle, Washington

### Background and Planning

In 2017, the Seattle Department of Transportation published the “New Mobility Playbook,” which they described as “a set of plays, policies, and strategies that will position Seattle to foster new mobility options while prioritizing safety, equity, affordability, and sustainability in our transportation system.” The playbook provides a brief history of transportation technologies in Seattle, establishes principles for new mobility, and identifies next steps.<sup>124</sup>

The principles for new mobility are as follows:

- Put people and safety first
- Design for customer dignity and happiness
- Advance racial and social justice
- Forge a clean mobility future
- Keep an even playing field

The playbook also identifies five “plays” or parameters for new mobility:

- Ensure new mobility delivers a fair and just transportation system for all
- Enable safer, more active and people-first uses of the public right of way
- Reorganize and retool SDOT to manage innovation and data
- Build new information and data infrastructure so new services can “plug-and-play”
- Anticipate, adapt to, and leverage innovative and disruptive transportation technologies

### Data

In 2018, Seattle conducted an evaluation of their bike share program, including data collection methods. For example, Seattle learned that “rides per bike per day is a less useful metric for free-floating than for dock-based bike share systems.” Seattle also learned that while trip start and end data was useful, waypoint data from the middle of a trip was also essential to fully understanding how people were using the bike share.<sup>125</sup>

While this information does not pertain directly to automated vehicles, lessons learned from other new mobility options may be applicable to automated vehicle pilots and deployments.

## Considerations for Pricing Highly Automated Vehicles by Occupancy

### Purpose of Pricing Automated Vehicles by Occupancy

A common question about highly automated vehicles is whether they will decrease or increase congestion. Automated vehicles could decrease congestion if people share rides, reducing the total number of vehicles on the road. In contrast, automated vehicles could increase congestion if rides are not shared and if increased

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124 Seattle Department of Transportation. 2017. “New Mobility Playbook.” Available at: <https://newmobilityseattle.info/>

125 Seattle Department of Transportation. 2018. “2017 Free-Floating Bike Share Pilot Evaluation Report.” Available at: <https://www.seattle.gov/Documents/Departments/SDOT/BikeProgram/2017BikeShareEvaluationReport.pdf>

convenience and lower costs encourage people to take more or longer trips. For example, in 2018 Fehr and Peers tested “how AVs might change the predicted outcomes of nine regional travel models from around the U.S.” and found that in all nine models, automated vehicles increased vehicle miles traveled (VMT).<sup>126</sup>

In particular, automated vehicles could enable zero-occupancy trips, trips with no human passengers. For example, an empty automated fleet vehicle could circle within an urban area awaiting a customer to call it to a specific location for pick-up. Alternatively, a personally-owned automated vehicle could drop the owner off at work and, rather than pay for parking, drive itself home and then return at the end of the day to pick the owner up. To keep congestion from increasing, the system may need to dis-incent owners (companies or individuals) from zero-occupancy operation. One identified method to discourage these scenarios is to charge fees on vehicles operating with zero occupancy.

Occupancy pricing policies could also promote ride-sharing and the use of high-occupancy vehicles, leading to more efficient use of road space. According to the Federal Highway Administration’s 2017 National Household Travel Survey, the mileage-weighted occupancy factor for all vehicles is 1.67.<sup>127</sup> Increasing the average vehicle occupancy by sharing rides in automated vehicles could decrease the number of vehicles on the road. This could improve congestion, although it’s important to note that potential congestion reduction depends on the mode shift; if the people choosing to share rides in automated vehicles previously used transit or active transportation options, vehicle miles traveled and congestion could increase.<sup>128</sup>

Reducing congestion and the total number of vehicles on the road could also provide a number of co-benefits. For example, reducing congestion has been shown to also reduce greenhouse gas emissions.<sup>129</sup> Congestion also contributes to air pollutants and increases the risk of crashes. Above a certain threshold, congestion can also begin to negatively affect the local economy.<sup>130</sup> If automated vehicles increase congestion, they could also worsen these second-order effects, making occupancy pricing and other strategies for congestion management more important.

## Methods of Pricing Automated Vehicles by Occupancy

Many jurisdictions in the U.S. already price vehicles by occupancy on highways and major thoroughfares through implementation of high-occupancy vehicle (HOV) or high-occupancy toll (HOT) lanes. An HOV lane is a restricted lane reserved for the exclusive use of vehicles with multiple occupants, with a typical minimum of two or three. HOV lanes are designed to encourage carpools, vanpools, and ridesharing as a means of reducing congestion. Vehicles in the HOV lane are usually exempt from tolls or pay reduced fees. For example, in Virginia drivers with three or more people in their cars can set their E-ZPass Flex to “HOV mode” and use the express lanes on I-495 and I-95 for free.<sup>131</sup> This type of HOV lane prices occupancy by reducing or waiving fees for vehicles with more passengers.

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126 Fehr and Peers. 2018. “Will AVs Dramatically Increase Vehicle Trips and VMT?” Available at: 2018. <https://www.fehrandpeers.com/autonomous-vehicle-research/>

127 Federal Highway Administration. 2019. “National Household Travel Survey.” Available at: <https://nhts.ornl.gov>

128 Fulton, Lew, Jacob Mason, and Dominique Meroux. UC Davis Institute of Transportation Studies and the Institute for Transportation Policy and Development. 2017. “Three Revolutions in Urban Transportation.” Available at: <https://www.itdp.org/2017/05/03/3rs-in-urban-transport/>

129 Barth, Matthew and Kanok Boriboonsomsin. Transportation Research Record, Journal of the Transportation Research Board, No. 2058. Transportation Research Board, National Academy of Science. 2008. “Real-World CO2 Impacts of Traffic Congestion.” Available at: 2008. <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.367.5168&rep=rep1&type=pdf>

130 Sweet, Matthias. Urban Studies Journal. 2013. “Traffic Congestion’s Economic Impacts: Evidence from US Metropolitan Regions.” Available at: <https://journals.sagepub.com/doi/abs/10.1177/0042098013505883>

131 Transurban Express Lanes. “Learn the Lanes.” Available at: <https://expresslanes.com/learn-the-lanes>

An HOT lane is an HOV lane that lower-occupancy vehicles can access by paying a fee, which in many cases varies by demand. HOV lanes are attractive even to low-occupancy vehicles because they are often less congested than mixed-use lanes. An HOT lane prices occupancy by both reducing or waiving fees for high-occupancy vehicles and imposing additional costs on lower-occupancy vehicles that use this faster-moving lane.

Both HOV and HOT lanes face challenges with compliance and enforcement. Image processing technologies that could help identify non-compliant vehicles have been hampered by windshield glares and poor lighting, so enforcement has by and large been conducted by police officers. In addition, HOV and HOT lanes are only used on highways or major thoroughfares and are not suitable for pricing occupancy in urban cores or on other types of roads. Furthermore, an unoccupied automated vehicle may not be able to switch an E-ZPass Flex to “HOV mode” or use other similar counting techniques designed for human drivers or passengers.

Researchers are exploring alternative methods of vehicle occupancy verification for purposes of pricing, including in-vehicle detection technology. Possibilities include weight sensors, infrared sensors, ultrasound and image sensors, which are already deployed for advanced safety functions such as airbag systems. Connected vehicle technology could provide another method of reporting vehicle occupancy. However, all of these technology solutions would require widespread adoption by automated vehicle manufacturers and could entail changes to federal motor vehicle design standards. These technological solutions may also raise privacy concerns regarding an individual’s geolocation data, which would need to be addressed before implementation.<sup>132</sup>

### **Task Force Recommendation**

The Task Force on Autonomous Vehicles has identified occupancy pricing as a central mechanism to reduce the potential for highly automated vehicles (HAVs) to negatively impact Oregon’s adopted policies and goals. The task force suggests further exploration of this method, and others, to ensure automated vehicles further Oregon’s adopted goals.

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132 Chan, Ching-Yao, Fanping Bu, Krute Singa, and Huili Wang. University of California, Berkeley. 2011., “Implementation and Evaluation of Automated Vehicle Occupancy Verification.” Available at: <http://actweb.org/wp-content/uploads/2016/04/CalTrans-Automated-Vehicle-Occupancy-Verification.pdf>

## Recommendations to Use Oregon’s Autonomous Vehicle Work to Further Existing State of Oregon Goals

The Task Force on Autonomous Vehicles recommends the State of Oregon’s work to integrate automated vehicles into its transportation system makes certain to:

1. Set the safety of people using the roadways as its first priority, supporting Oregon’s Transportation Plan,<sup>133</sup> Transportation Safety Action Plan,<sup>134</sup> Bicycle and Pedestrian Plan,<sup>135</sup> Transportation Options Plan,<sup>136</sup> and ODOT’s Key Performance Measures for safety,<sup>137</sup> and ODOT’s mission of zero fatal and serious injuries by 2035.
2. Take advantage of key opportunities to meet its commitment to reducing greenhouse gas emissions under 2017 ORS 468A.205,<sup>138</sup> the Statewide Transportation Strategy,<sup>139</sup> and metropolitan planning organization plans. This may include giving preferences to lower-polluting forms of travel, creating incentives for lower-polluting travel by autonomous vehicles (such as electric vehicles or high-occupancy trips), and exploring options to reduce overall trips.
3. Further (and avoid undermining) the goals of the Oregon Public Transportation Plan,<sup>140</sup> particularly equity, mobility, and funding.
4. Further the goals of the Oregon Transportation Plan,<sup>141</sup> particularly funding the transportation system, mobility and accessibility, sustainability and economic vitality.
5. Support Oregon’s Land Use Planning Goals,<sup>142</sup> particularly housing, transportation, and urbanization goals.
6. Emphasize Business Oregon’s Strategic Plan Priorities,<sup>143</sup> particularly in innovation and growth of small and middle-market companies.

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133 Oregon Department of Transportation. 2006. “Oregon Transportation Plan.”

134 Oregon Department of Transportation. 2016. “Oregon Transportation Safety Action Plan.” Available at: [https://www.oregon.gov/ODOT/Safety/Documents/TSAP\\_2016.pdf](https://www.oregon.gov/ODOT/Safety/Documents/TSAP_2016.pdf)

135 Oregon Department of Transportation. 2016. “Oregon Bicycle and Pedestrian Plan.” Available at: <https://www.oregon.gov/ODOT/Planning/Documents/OBPP.pdf>

136 Oregon Department of Transportation. 2015. “Oregon Transportation Options Plan.” Available at: <https://www.oregon.gov/ODOT/Planning/Documents/OTOP.pdf>

137 Oregon Department of Transportation. 2019. “Key Performance Measures.” Available at: <https://www.oregon.gov/odot/performmang/pages/index.aspx>

138 Oregon Revised Statutes. “ORS 468A.205: Policy – greenhouse gas emissions reduction goals.” Available at: <https://www.oregonlaws.org/ors/468A.205>

139 Oregon Department of Transportation. 2013. “Statewide Transportation Strategy.” Available at: <https://www.oregon.gov/ODOT/Planning/Pages/STS.aspx>

140 Oregon Department of Transportation. 2018. “Oregon Public Transportation Plan.” Available at: [https://www.oregon.gov/ODOT/Planning/Documents/OTPP\\_V1\\_FINAL\\_Feb2019.pdf](https://www.oregon.gov/ODOT/Planning/Documents/OTPP_V1_FINAL_Feb2019.pdf)

141 Oregon Department of Transportation. 2006. “Oregon Transportation Plan.”

142 Oregon Department of Land Conservation and Development. 2010. “Oregon’s Statewide Land use Planning Goals.” Available at: <https://www.oregon.gov/lcd/OP/Pages/Goals.aspx>

143 Business Oregon. 2018. “Prosperity for All Oregonians: Business Oregon Strategic Plan, 2018-2022.” Available at: <https://www.oregon4biz.com/Publications/Strategic-Plan/>

## Land Use: Studies and References

### Introduction

This document is a compilation of the studies and references used or discussed in the Subcommittee on Land Use. It also includes some relevant documents collected by ODOT staff and subcommittee members. This list is intended to help policymakers carry out further research and demonstrate some of the grounding for the task force's work products.

### Studies and References

#### **Global Atlas of AVs in Cities**

Bloomberg / Aspen Institute

<https://avsincities.bloomberg.org/global-atlas>

#### **Blueprint for Autonomous Urbanism**

National Association of City Transportation Officials (NACTO)

<https://nacto.org/publication/bau/blueprint-for-autonomous-urbanism/>

#### **Cities in the Driving Seat**

Siemens

<https://w3.siemens.com/topics/global/en/intelligent-infrastructure/Pages/cities-driving-seat.aspx>

#### **The Impact of AVs and E-Commerce on Local Government Budgeting and Finance**

Urbanism Next Center

[https://urbanismnext.uoregon.edu/files/2017/06/AV-and-E-commerce-Municipal-Finance-White-Paper\\_082318-13b66ld.pdf](https://urbanismnext.uoregon.edu/files/2017/06/AV-and-E-commerce-Municipal-Finance-White-Paper_082318-13b66ld.pdf)

#### **New Mobility in the Right-of-Way**

Urbanism Next / Carbon Neutral Cities Alliance

[http://carbonneutralcities.org/wp-content/uploads/2019/03/4.New-Mobility-in-the-Right-of-Way\\_March-2019.pdf](http://carbonneutralcities.org/wp-content/uploads/2019/03/4.New-Mobility-in-the-Right-of-Way_March-2019.pdf)

#### **San Francisco Curb Study**

Fehr & Peers / Uber

<https://www.fehrandpeers.com/sf-curb-study/>

#### **Preparing Cities for an Automated Future: Parking, Curb Zones, and City Services**

National Institute for Transportation and Communities (NITC)

[https://nitc.trec.pdx.edu/news/preparing-cities-automated-future-parking-curb-zones-and-city-services?utm\\_source=ActiveCampaign&utm\\_medium=email&utm\\_content=Preparing+Cities+For+an+Automated+Future%3A+Curb+Space+Re-Use+and+City+Services&utm\\_campaign=NITC+Monthly+%28May+2019%29](https://nitc.trec.pdx.edu/news/preparing-cities-automated-future-parking-curb-zones-and-city-services?utm_source=ActiveCampaign&utm_medium=email&utm_content=Preparing+Cities+For+an+Automated+Future%3A+Curb+Space+Re-Use+and+City+Services&utm_campaign=NITC+Monthly+%28May+2019%29)

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# Public Transit

## Scope of the Materials and Recommendations

This section of the report contains materials prepared by the Subcommittee on Public Transit and approved by the full Task Force on Autonomous Vehicles. The subcommittee summarized several pilot projects and demonstrations that combine public transit and automated vehicle technologies. These include projects from other states and from around the world.

The subcommittee also provided recommendations for how to use automated vehicle technology to enhance and preserve public transit, as well as recommendations for using automated vehicle technology to improve safety and access to transit. To help policymakers consider how automated vehicles could impact different components of the public transit system in Oregon, the subcommittee prepared a matrix of all the different components and briefly noted how public transit could incorporate different levels of automation.

## Samples of Public Transit and Automated Vehicle Partnerships

### Introduction

This memo highlights select sample initiatives underway through partnerships between local jurisdictions, transit agencies and autonomous vehicle manufacturers to prepare for automated vehicle technology integration with public transit. The samples below provide an overview of some pilots and work in this field, but are not intended to be comprehensive.

### Sample Partnerships

#### Utah Department of Transportation and Utah Transit Authority

The Utah Department of Transportation and Utah Transit Authority started a year-long pilot of autonomous shuttle technology in April of 2019. The shuttle, provided by EasyMile, operates on several fixed routes throughout Utah. The purpose of the pilot is to identify opportunities for the application of autonomous vehicle technology and to educate the public about autonomous vehicles. More information about the Utah Autonomous Shuttle Pilot can be found here: <http://www.avshuttleutah.com/>



#### Contra Costa Transportation Authority (CCTA) and GoMentum Station

The Contra Costa Transportation Authority (CCTA) and GoMentum Station are testing an autonomous shuttle at Bishop Ranch, the largest mixed-use business community in Northern California, located in the city of San Ramon. This marks the first time the California Department of Motor Vehicles (DMV) has allowed a shared autonomous vehicle to travel on public roads in the state. After successful testing at the GoMentum Station autonomous vehicle proving grounds in Concord, California and in parking lots at Bishop Ranch, CCTA is advancing to the third phase of testing. The vehicles are currently staffed by trained testers. It is anticipated that additional predetermined



testers and evaluators chosen from employees of various employers within Bishop Ranch will be able to ride the vehicles as they traverse public streets within the business park. More information about this test can be found here: <https://ccta.net/2018/10/16/first-autonomous-shuttle-test-on-public-roads-in-ca/>

### **Livermore Amador Valley Transit Authority (LAVTA) Shared Autonomous Vehicle (SAV)**

The Livermore Amador Valley Transit Authority (LAVTA), operators of the popular Wheels and Rapid bus services and the Go Dublin partnership with transportation network companies, is exploring an innovative shared autonomous vehicle demonstration project within the City of Dublin in collaboration with the City of Dublin, Contra Costa County Transportation Authority, First Transit and the GoMentum Station in Concord, California. One project site is the East Dublin/Pleasanton BART station. LAVTA's goals for the shared autonomous vehicle demonstration project include: creating a mode shift from single-occupant vehicles to transit to decrease congestion and improve the environment; improving trip reliability and safety; increasing transit jobs by increasing transit ridership and demand; and increasing farebox recovery for transit operations. More information can be found here: <https://www.wheelsbus.com/sav/> and here: [https://www.wheelsbus.com/wp-content/uploads/2017/08/SAV-Brochure\\_Web.pdf](https://www.wheelsbus.com/wp-content/uploads/2017/08/SAV-Brochure_Web.pdf)



### **Houston METRO and Texas Southern University**

Houston METRO has partnered with Texas Southern University for a pilot program in which an autonomous shuttle will operate on a 1-mile, closed-loop route along TSU's Tiger Walk. To ensure customer safety, an attendant will be on board the shuttle during this pilot program but will not actually be operating it. The all-electric vehicle seats six people, with standing room for six others and operates on weekdays only. A 2017 statute approved the operation of autonomous vehicles on Texas roads. More information can be found here: <https://www.ridemetro.org/Pages/Autonomous-Vehicles.aspx>



### **Denver Regional Transportation District (RTD) 61AV Pilot**

After a six-month pilot, Denver RTD concluded service of their self-driving shuttle that connected passengers from the 61st and Peña commuter rail station to the Panasonic and EasyMile offices. The 61AV aimed to evaluate the use of an autonomous vehicle to offer first- and last-mile connections. RTD collaborated with the city and county of Denver, EasyMile (which supplied the vehicle), Panasonic, Transdev and L.C. Fulenwider, Inc. RTD explained that in addition to testing AV technology in a transit environment, the pilot program provided the partners with the ability to learn how such vehicles can be used in a variety of community settings. RTD staff will present the results of the pilot program to the RTD Board of Directors with the intent of exploring other opportunities to test self-driving shuttles as an option for moving RTD passengers. More at: <https://www.masstransitmag.com/alt-mobility/shared-mobility/bicycle-scooter-sharing/press-release/21091581/regional-transportation-district-rtd-denver-rtd-wraps-up-61av-autonomous-pilot>



## Phoenix Valley Metro and Waymo

Valley Metro operates regional transit services in Phoenix, Arizona. On July 31, 2018, Valley Metro announced a two-year partnership with Waymo. The first pilot in this partnership offered Valley Metro employees who reside in Waymo's service area the option to take first/last mile trips in Waymo's self-driving cars to transit stops. Over the past year, approximately 30-40 employees made about 500 trips on the pilot service. The second pilot in this partnership will expand to serve customers of Valley Metro's RideChoice program, an on-demand taxi service offering discounted rates for seniors and people with disabilities, by offering RideChoice and paratransit customers that live in Waymo's service area the option to hail Waymo's self-driving vehicles for curb-to-curb service. Valley Metro is identified as a strategic partner in FTA's Strategic Transit Automation Research Plan;<sup>144</sup> in this role, Valley Metro will exchange knowledge and lessons learned about the pilot demonstration with the FTA and the rest of the transit industry. Valley Metro was awarded \$250,000 from the Federal Transit Administration's (FTA) Mobility On Demand Sandbox grant to pair research activities with the Waymo/RideChoice pilot. Valley Metro is partnered with Arizona State University to conduct this research and to collect data, conduct analysis, evaluate the project and develop a lessons learned report. More information about Valley Metro's Waymo partnership can be found here: <https://www.valleymetro.org/future>.



## Columbus Smart Circuit Automated Shuttle Pilot

A low-speed, automated shuttle is operating in downtown Columbus, Ohio on a pilot basis until fall 2019. The shuttle carries up to six passengers at a time and operates on a 1.5 mile loop with a handful of stops at popular tourist destinations. A fleet attendant is on board the vehicle. The pilot had served 9,000+ riders as of April 30, 2019. It is planned to expand to serve a 2.7-mile residential route later this year. This pilot was sponsored by a partnership among City of Columbus, Ohio Department of Transportation, Ohio State University, and automated shuttle manufacturer May Mobility. More information about the Smart Circuit pilot can be found here: <https://smartcircuitbus.com/>



## Mercedes-Benz Future Bus

Mercedes-Benz demonstrated its Future Bus on a 12-mile route in the Netherlands in 2016. The Future Bus uses CityPilot, automated driving technology that relies on GPS, cameras, and long- and short-range radar systems to help the vehicle navigate complex urban areas. The bus can recognize obstacles, especially pedestrians, and brake automatically. It recognizes traffic lights, communicates with them and safely negotiates junctions controlled by them. It approaches bus stops automatically, where it opens and closes its doors. It is also able to drive through tunnels. More information about this project can be found here: <https://www.daimler.com/innovation/autonomous-driving/future-bus.html>



144 Federal Transit Administration. January 2018. "Strategic Transit Automation Research Plan." Available at: [https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/research-innovation/114661/strategic-transit-automation-research-report-no-0116\\_0.pdf](https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/research-innovation/114661/strategic-transit-automation-research-report-no-0116_0.pdf)

## Siemens Mobility Autonomous Tram

Siemens Mobility, together with ViP Verkehrsbetrieb Potsdam GmbH, presented a research project on the world's first autonomous tram at InnoTrans 2018, with a demonstration running in real traffic along a six kilometer section of the tram network in Potsdam, Germany. The experimental tram being used to demonstrate autonomous driving at the world premiere is not designed for commercial use. The current project aims at identifying the technological challenges of autonomous driving under real-life conditions, then developing and testing solutions for them. More on this project can be found here: <https://press.siemens.com/global/en/pressrelease/siemens-mobility-presents-worlds-first-autonomous-tram?content>



## Recommendations for Public Transit and Automated Vehicles

### Introduction

This memo highlights priority recommendations regarding public transit and automated vehicles. These recommendations are intended to be built upon, and complementary to, existing guidance documents and adopted plans listed at the end of this memo.

### Recommendations

#### Preserve and Enhance Public Transit:

- Use automated vehicle technology to preserve and enhance public transit service and access throughout Oregon for all people.
- Increase transit mode share with high occupancy public transit vehicles and routes, dedicating space where needed for transit to succeed, especially where public transit is most efficient.
- Provide equitable service through a careful evaluation of people and locations served, including exploration of on-demand automated transit in rural areas.
- Where possible, coordinate with automated vehicle fleet services to reduce competition with public transit already in place.

#### Utilize AV technology to Improve Safety and Expand Access to Transit:

- Encourage public transit operators to test and utilize automated driving systems and automated driver assistance technology to improve operations of public transit systems.
- Improve safety outcomes for all passengers onboard transit vehicles and for all roadway users outside of transit vehicles, including cyclists, pedestrians, and other vulnerable road users.
- Support and evaluate testing and deployment of automated shuttles and other related technology as early opportunities to learn about the potential utilization of the technology.
- Ensure that AVs can strengthen and enhance public transit by integrating first and last mile solutions to increase the reach of public transit.
- Investigate how automated vehicle technology could be incorporated into all types of transit (as outlined in the matrix on pg. 2) and identify differential needs and opportunities.

- Identify funding opportunities and provide technical support for the creation of mobility hubs as a means to facilitate more seamless transfers between multimodal transportation options.

The following documents offer additional statewide context:

- Oregon Public Transportation Plan: <https://www.oregon.gov/ODOT/Planning/Pages/OTP.aspx>
- Emerging Technologies Impact Assessment: <https://www.oregon.gov/ODOT/Planning/Pages/ETIA.aspx>

# PUBLIC TRANSIT IN OREGON BY TYPE

Commuter Rail or Heavy Rail	Light Rail	Streetcar	Bus Rapid Transit or Higher-capacity Bus	Standard Bus or Local Shuttle	Paratransit	Express Connections
						
Mostly dedicated right of way (ROW), but shared with freight trains; Some crossings at grade.	Mostly dedicated ROW; Often crosses other modes at-grade; Uses transit-specific signals.	Part dedicated ROW, part mixed traffic; Uses transit-specific signals.	Some dedicated ROW, some mixed traffic; May have transit specific signal phases.	Generally operates in mixed traffic; Targeted bus priorities treatments where possible.	Door-to-door service for those who qualify; Many customers need help with boarding and securement device.	Mixed traffic; Long distances between stops; Services a few key points on longer routes.



## Potential Evolution in SAE Levels Toward Automation Level 5

SAE Level	1			Driver assistance technology, including safety advisory information and momentary assistance (e.g., collision warnings, automatic emergency braking)	
	2	SAE levels and taxonomy (J3016) were developed for on-road motor vehicles.	SAE levels and taxonomy (J3016) were developed for on-road motor vehicles.	SAE levels and taxonomy (J3016) were developed for on-road motor vehicle.	Partial automation to enhance safety and support driver (e.g., lane centering, adaptive cruise control)
	3	Automated technology is being developed for this type of transportation.	Automated technology is being developed for this type of transportation.	Automated technology is being developed for this type of transportation.	Conditional automation in service with operator override when needed
	4				Vehicle may operate in automated mode with no human intervention, but only within certain parameters. For example, the AV may only have detailed mapping information for Portland and would not be able to operate outside the city.  Employee may not always be on board. Other operations needs define positions (customer service, concierge, fare enforcement, security).
	5				Fully automated. Employee may not always be on board. Other operations needs define positions (customer service, concierge, fare enforcement, security).

# Public Transit: Studies and References

## Introduction

This document is a compilation of the studies and references used or discussed in the Subcommittee on Public Transit. It also includes some relevant documents collected by ODOT staff and subcommittee members. The list includes both approved recommendations from national organizations such as NACTO, as well as studies from consultants and research institutes. This list is supposed to help policymakers carry out further research and demonstrate some of the grounding for the task force's work products.

## Studies and References:

### **Automated Vehicles Have Arrived: What's a Transit Agency to Do?**

Mineta Transportation Institute

[https://scholarworks.sjsu.edu/cgi/viewcontent.cgi?article=1256&context=mti\\_publications](https://scholarworks.sjsu.edu/cgi/viewcontent.cgi?article=1256&context=mti_publications)

### **Blueprint for Autonomous Urbanism<sup>145</sup>**

National Association of City Transportation Officials

<https://nacto.org/publication/bau/blueprint-for-autonomous-urbanism/>

### **Low-Speed Automated Shuttles: State of the Practice**

U.S. Department of Transportation

<https://rosap.nhtl.bts.gov/view/dot/37060>

### **Mobility Innovation Hub**

American Public Transportation Association

<https://www.apta.com/research-technical-resources/mobility-innovation-hub/>

### **Oregon Public Transportation Plan 2019**

Oregon Department of Transportation

[https://www.oregon.gov/ODOT/Planning/Documents/OPTP\\_Volume2\\_Final\\_Feb19.pdf](https://www.oregon.gov/ODOT/Planning/Documents/OPTP_Volume2_Final_Feb19.pdf)

### **State of Transit and Finding a Connection in a 'Connected' World**

Peter Costa, 2018 AASHTO Council Public Transportation & MTAP Winter Meeting

<https://mtap.transportation.org/wp-content/uploads/sites/42/2018/11/Pete-Costa-AASHTO-Presentation.pdf>

### **Strategic Transit Automation Research Plan**

Federal Transit Administration

[https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/research-innovation/114661/strategic-transit-automation-research-report-no-0116\\_0.pdf](https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/research-innovation/114661/strategic-transit-automation-research-report-no-0116_0.pdf)

### **Transit and Emerging Technologies**

Nelson/Nygaard

<https://umjp9n8g2j2ft5j5637up17u-wpengine.netdna-ssl.com/wp-content/uploads/2019/02/Transit-and-Emerging-Technologies.pdf>

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145 An update to NACTO's Blueprint for Autonomous Urbanism is expected in the fall of 2019.

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# Workforce Changes

## **Scope of the Materials and Recommendations**

This section of the report contains materials prepared by the Subcommittee on Workforce Changes and approved by the full Task Force on Autonomous Vehicles. Gail Krumenauer, Senior Economic Analyst at the Oregon Employment Department, prepared a report for the task force. The report identifies primary and secondary occupations that could be affected by automated vehicle deployment, projects employment changes for those occupations, and estimates the potential job effects of mainstream AV adoption.

The task force recommends the Legislature authorize and fund an independent workforce study, and recommends elements to be included in this broader, more comprehensive workforce study. The recommendations call for a quantitative analysis and identification of potential policy interventions. This document builds on a recommendation made by the Task Force on Autonomous Vehicles in 2018: to conduct an independent workforce study.

**Contact:** Gail Kiles Krumenauer, 503-947-1268

## Occupations Affected by Autonomous Vehicle Adoption in Oregon

In 2018, HB 4063 established the Oregon Department of Transportation (ODOT) as the lead agency for automated vehicle (AV) policy in the state. HB 4063 also requires ODOT to convene and facilitate a Task Force on Autonomous Vehicles.

Oregon's AV Task Force consists of leaders and experts from various state agencies, labor organizations, private employers, and state lawmakers. The Task Force is currently in its second phase, working primarily through six subcommittees to develop recommendations for the Oregon Legislature related to AV adoption.

Each subcommittee focuses on one subject area related to autonomous vehicles: road and infrastructure design; public transit; vehicle code amendments and public safety; cybersecurity and privacy; land use; and workforce changes. This summary provides labor market information related to occupations most likely to see workforce reductions associated with autonomous vehicle adoption over the next 20 to 30 years in Oregon.

### Measuring Employment in Oregon's AV-Affected Occupations

A 2017 paper from economists in the U.S. Department of Commerce Economics and Statistics Administration<sup>146</sup> identifies primary driving and other on-the-job driving-related (or "secondary") occupations most likely to be affected by AV adoption in the U.S. Primary driving occupations include light

### Defining "Affected" Occupations and Timelines

Affected occupations are not synonymous with lost jobs. Some jobs in AV-affected occupations may be eliminated, while others will change substantially over the next 20 to 30 years, but still exist. In other areas of the economy, new jobs and entirely new occupations will also be created due to mainstream AV adoption.

Timelines are also important. One study prepared by the UC-Berkeley Labor Center suggests widespread AV adoption will take between 25 and 30 years for commercial trucks. Another study prepared for Securing America's Future Energy estimates widespread household AV adoption starting around the year 2030, and full commercial truck automation occurring through the 2040s.

<sup>146</sup> Beede, Powers, and Ingram. August 2017. "The Employment Impact of Autonomous Vehicles." Office of the Chief Economist, Economics and Statistics Administration, U.S. Department of Commerce. ESA Issue Brief #05-17

and heavy-duty drivers, whose primary responsibilities include driving cars, vans, small trucks or heavy-duty commercial vehicles on the road.<sup>147</sup> Secondary occupations include those where driving is not the primary responsibility, but often required, and some jobs could be eliminated by AVs.

Estimates from the Oregon Employment Department’s long-term occupational projections show nearly 95,000 jobs statewide in AV-affected occupations in 2017. That accounts for 5 percent of all employment, with 56,000 jobs across the eight primary driving occupations, and 39,000 jobs in the 14 secondary AV-affected occupations.

Among primary driving occupations, the median (or middle among all jobs) hourly wage in 2019 ranged from a low of \$13.56 for taxi drivers and chauffeurs to a high of \$25.36 for transit and intercity bus drivers. For secondary affected occupations, median hourly wages varied from \$12.31 for service station attendants to \$48.80 for supervisors and managers of police and detectives. By comparison, the median wage for all occupations in Oregon was \$19.46 per hour.

### Employment and Wages for Autonomous Vehicle-Affected Occupations in Oregon

<b>Standard Occupational Classification Title</b>	<b>2017 Employment</b>	<b>2019 Median Hourly Wage</b>
<b>Total, All Occupations</b>	<b>2,045,907</b>	<b>\$19.46</b>
All Autonomous Vehicle-Affected Occupations	94,776	-
Truck Drivers, Heavy and Tractor-Trailer	24,289	\$22.82
Truck Drivers, Light or Delivery Services	10,532	\$17.10
Driver/Sales Workers	7,282	\$15.24
Bus Drivers, School or Special Client	6,634	\$17.44
Taxi Drivers and Chauffeurs	2,795	\$13.56
Bus Drivers, Transit and Intercity	2,326	\$25.36
Motor Vehicle Operators, All Other	2,167	\$14.47
Ambulance Drivers and Attendants, Except Emergency Medical Technicians	77	\$12.71
Security Guards	8,527	\$13.31
Automotive Service Technicians and Mechanics	7,423	\$21.19
Service Station Attendants	5,912	\$12.31
Police and Sheriff's Patrol Officers	5,289	\$35.57
Postal Service Mail Carriers	3,496	\$22.90
Refuse and Recyclable Material Collectors	2,199	\$22.43
Automotive Body and Related Repairers	1,971	\$18.81
Couriers and Messengers	1,406	\$16.43
Supervisors and Managers of Police and Detectives	1,293	\$48.80
Parking Lot Attendants	745	\$12.81
Automotive Glass Installers and Repairers	271	\$15.82
Travel Guides	82	\$15.81
Electronic Equipment Installers and Repairers, Motor Vehicles	60	\$20.10
Insurance Appraisers, Auto Damage	-s-	\$35.96

Cells with "-s-" suppressed for confidentiality or data quality

Sources: Oregon Employment Department, 2017-2027 Employment Projections  
2019 Occupational Wage Information

primary driving occupation

secondary affected occupation

147 Groshen, Helper, MacDuffe, and Carson. June 2018. "Preparing U.S. Workers and Employers for an Autonomous Vehicle Future." Prepared for Securing America's Future Energy.

## Projected Employment Changes for AV-Affected Occupations

Oregon's current long-term projections estimate employment changes through 2027, which falls before the window of mainstream AV adoption identified in academic studies.<sup>148</sup> Between 2017 and 2027, Oregon will add 246,000 jobs, a growth rate of 12 percent (Table 2). Primary driving occupations are also projected to grow by 12 percent, adding 6,500 new jobs over the decade. The fastest growth among this set of occupations is expected for light truck drivers and taxi drivers and chauffeurs (17% each). *Note these projections include self-employment.*

Secondary AV-affected occupations will add 2,900 jobs (8%). Couriers and messengers' employment will grow 14 percent by 2027, the fastest among this set of occupations. Meanwhile, two others – postal service mail carriers, and motor vehicle electronic equipment installers and repairers – will see employment declines by 2027.

Across all occupations in Oregon, for every one new job created, there will also be roughly nine job openings requiring newly trained workers to replace those who leave the labor force (largely due to retirement) or make major occupational changes. Among primary driving occupations, that ratio will be 10-to-1, and among secondary affected occupations, projections show 15 replacement openings for every one new job by 2027. Overall, primary driving and secondary AV-affected occupations will account for 117,500 of Oregon's 2.6 million total job openings.

**2017-2027 Employment Projections for Primary Driving and Secondary AV-Affected Occupations in Oregon**

Occupation Title	2017 Employment	2027 Employment	Percent Change	Employment Change	Replacement Openings	Total Openings
<b>Total, All Occupations</b>	<b>2,045,907</b>	<b>2,291,921</b>	<b>12%</b>	<b>246,014</b>	<b>2,383,309</b>	<b>2,629,323</b>
<b>Primary Driving Occupations</b>	<b>56,102</b>	<b>62,641</b>	<b>11.7%</b>	<b>6,539</b>	<b>65,168</b>	<b>71,707</b>
Ambulance Drivers and Attendants, Except Emergency Medical Technicians	77	88	14%	11	117	128
Bus Drivers, Transit and Intercity	2,326	2,571	11%	245	2,921	3,166
Bus Drivers, School or Special Client	6,634	7,297	10%	663	8,309	8,972
Driver/Sales Workers	7,282	7,650	5%	368	7,856	8,224
Truck Drivers, Heavy and Tractor-Trailer	24,289	26,988	11%	2,699	26,977	29,676
Truck Drivers, Light or Delivery Services	10,532	12,347	17%	1,815	12,036	13,851
Taxi Drivers and Chauffeurs	2,795	3,270	17%	475	3,028	3,503
Motor Vehicle Operators, All Other	2,167	2,430	12%	263	3,924	4,187
<b>Secondary Affected Occupations</b>	<b>38,674</b>	<b>41,564</b>	<b>7.5%</b>	<b>2,890</b>	<b>42,908</b>	<b>45,798</b>
Insurance Appraisers, Auto Damage	-s-	-s-	-s-	-s-	-s-	-s-
Supervisors and Managers of Police and Detectives	1,293	1,376	6%	83	784	867
Police and Sheriff's Patrol Officers	5,289	5,663	7%	374	3,456	3,830
Security Guards	8,527	9,544	12%	1,017	11,732	12,749
Travel Guides	82	91	11%	9	148	157
Couriers and Messengers	1,406	1,597	14%	191	1,344	1,535
Postal Service Mail Carriers	3,496	3,354	-4%	-142	2,288	2,146
Electronic Equipment Installers and Repairers, Motor Vehicles	60	59	-2%	-1	57	56
Automotive Body and Related Repairers	1,971	2,131	8%	160	1,932	2,092
Automotive Glass Installers and Repairers	271	289	7%	18	266	284
Automotive Service Technicians and Mechanics	7,423	7,854	6%	431	7,019	7,450
Parking Lot Attendants	745	764	3%	19	1,107	1,126
Service Station Attendants	5,912	6,473	9%	561	10,077	10,638
Refuse and Recyclable Material Collectors	2,199	2,369	8%	170	2,698	2,868

Cells with "-s-" suppressed for confidentiality or data quality

Source: Oregon Employment Department, 2017-2027 Employment Projections

Primary and secondary occupations as defined by Chief Economist Office, Economics and Statistics Administration, U.S. Dept. of Commerce

148 Beede, 2017. Groshen, 2018.

## Potential Job Effects from Mainstream AV Adoption

A 2018 report prepared by Groshen, Helper, MacDuffe, and Carson for Securing America’s Future Energy (SAFE) outlines a framework for determining the shares of jobs in primary driving and secondary AV-affected occupations under four different autonomous vehicle adoption scenarios.<sup>149</sup> The report assumes household and commercial AV adoption occur separately from one another, on slightly different timeframes.

The report identifies two household AV adoption scenarios.<sup>150</sup> In one scenario, most households own their autonomous vehicle (“Cars Personal”). The other household scenario involves the use of AVs through a shared fleet of vehicles owned by a company (“Cars Fleet”). Both scenarios assume household AV adoption begins around 2020, and rapid adoption starts near 2030.

The SAFE report also identifies two commercial AV adoption scenarios.<sup>151</sup> Under “Trucking slow” adoption, Level 1/2 automation becomes mainstream in the 2020s, Level 3/4 automation goes mainstream in the 2030s, and advanced Level 4/5 starts becoming available in the 2040s. Their “Trucking Fast” scenario uses the same progression, and assumes roughly 10 years faster timeline, with Level 4/5 full automation nearly complete in the 2040s.

Under each of these scenarios, the SAFE report estimates the share of jobs affected in primary driving and secondary AV-affected occupations (see Appendix A).<sup>152</sup> The 2027 employment estimates for primary driving and secondary AV-affected occupations in Oregon combined with the SAFE shares of affected jobs in those occupations create a foundation for additional analysis. Using these numbers, we can make rough estimates of the number of Oregon jobs affected by the 2040s under each combination of household and commercial AV adoption scenarios (see Appendix B for more details).

Oregon’s primary driving occupations and secondary AV-affected occupations will still account for 5 percent of total employment with 104,000 jobs in 2027. Over the following 10 to 15 years, the household AV adoption scenarios could affect between 11,700 and 14,700 jobs. That totals between 11 percent and 14 percent of all jobs in those occupations. Commercial trucking scenarios could affect between 29,800 and 32,600 jobs in these occupations looking into the 2040s. Those impacts would be felt for between 29 and 31 percent of all jobs in primary driving and secondary affected occupations.

<b>Combined Household and Commercial Scenario</b>	<b>Jobs Affected*</b>
Personal cars + slow trucking	41,500
Fleet cars + slow trucking	44,400
Personal cars + fast trucking	44,300
Fleet cars + fast trucking	47,200

*\*Affected does not always equal “lost.” Some affected occupations may still exist, with notably different skills and responsibilities on the job.*

*Sources: Oregon Employment Department calculations using framework from Preparing U.S. Workers and Employers for an Autonomous Vehicle Future, Groshen et al., June 2018*

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149 Groshen, 2018, p.32-33

150 Ibid, p.31-32

151 Ibid, p.34

152 Ibid, p.37

Taken together, the various combinations of personal and commercial AV adoption scenarios could affect between 41,500 and 47,200 jobs in Oregon, starting around the year 2030 (see Appendix B). The largest impacts would occur for heavy and tractor-trailer truck drivers under the commercial scenarios, where 16,200 to 17,500 jobs could be affected. Under the household AV adoption scenarios, estimated job effects are largest for automotive service technicians and mechanics (4,000) and service station attendants (2,600 to 3,900).

### Additional Considerations

Workers in primary driving jobs affected by AV adoption are slightly more likely to be workers nearing retirement. While one out of every four jobs in Oregon is held by a worker age 55 or older, about one-third of workers in primary driving jobs are at least 55 years old (see Appendix C).

The mainstream adoption of autonomous vehicles will also create new jobs and entirely new occupations in transportation, in supplier and support activities related to AVs, and in other areas of the economy. Future research efforts can more fully capture workforce effects by including an analysis of new and emerging occupations related to autonomous vehicles.

In addition, we currently only have the capacity to discuss net employment changes beyond 2027. Yet net employment growth accounts for approximately one-tenth of total job openings. We expect autonomous vehicles to disrupt the pattern of replacement job openings, which account for the bulk of total openings. We currently lack a framework to quantify that change.

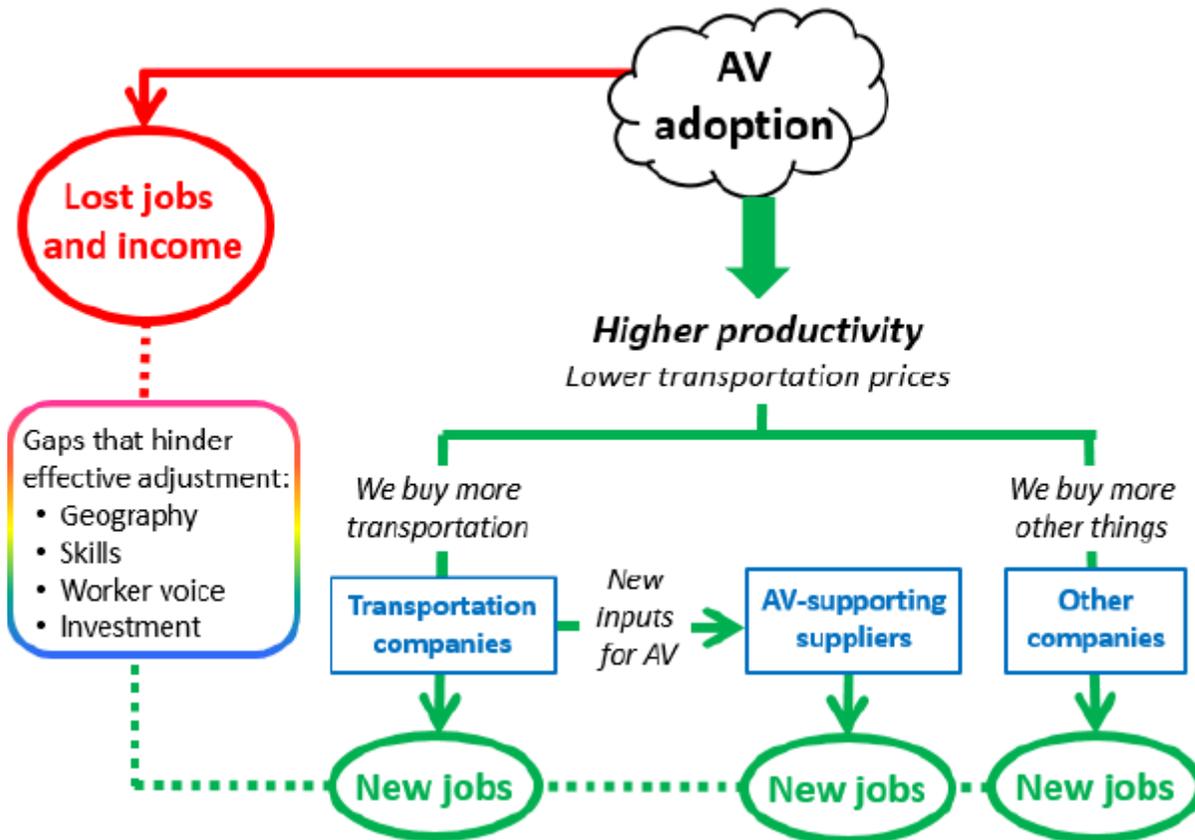


Figure 3: Source: Securing America’s Future

## Appendix A: Shares of Jobs Affected by Occupation and Autonomous Vehicle Adoption Scenario

Occupation	Employment Level in thousands 2016	Share of jobs eliminated under full implementation of scenario				Number of jobs eliminated under full implementation of scenarios			
		Trucking-Fast	Trucking-Slow	Cars-Fleet	Cars-Personal	Trucking-Fast	Trucking-Slow	Cars-Fleet	Cars-Personal
<b>Primary Driver Occupations</b>									
Heavy and Tractor-Trailer Truck Drivers	1,532	0.65	0.6	0	0	996	919		
Light Truck or Delivery Services Drivers	781	0.55	0.45	0	0	430	351		
Bus Drivers, School or Special Client	212	0.5	0.5	0	0	106	106		
Driver/Sales Workers	383	0	0	0.2	0.2			77	77
Taxi Drivers and Chauffeurs	300	0	0	0.7	0.2			210	60
Bus Drivers, Transit and Intercity	75	0.75	0.7	0	0	56	53		
Ambulance Drivers and Attendants, Except Emergency Medical Technicians	10	0.05	0.05	0.05	0.05	1	1	1	1
<b>Primary Driver Total (percent of total jobs)</b>	<b>3,293</b>					<b>1,588 (48%)</b>	<b>1,430 (43%)</b>	<b>287 (9%)</b>	<b>137 (4%)</b>
<b>Other On-The-Job Driver Occupations</b>									
Security Guards	646	0.024	0.024	0.024	0.024	16	16	16	16
Police and Sheriff's Patrol Officers	673	0.05	0.04	0.05	0.05	34	27	34	34
Automotive Service Technicians and Mechanics	711	0.1	0.1	0.5	0.5	71	71	356	356
Postal Service Mail Carriers	271	0	0	0.2	0.2			54	54
Parking Lot Attendants	48	0	0	0.5	0.5			24	24
Automotive Body and Related Repairers	116	0.05	0.05	0.5	0.5	6	6	58	58
Refuse and Recyclable Material Collectors	64	0.5	0.5	0.0	0.0	32	32		
Automotive and Watercraft Service Attendants	57	0	0	0.6	0.4			34	23
First-Line Supervisors of Police and Detectives	103	0.05	0.05	0.05	0.05	5	5	5	5
Couriers and Messengers	143	0	0	0.02	0.02			28	28
Automotive Glass Installers and Repairers	15	0	0	0.25	0.25			4	4
Insurance Appraisers, Auto Damage	14	0.3	0.2	0.25	0.25	4	3	4	4
Electronic Equipment Installers and Repairers, Motor Vehicles	7	0	0	0.5	0.5			4	4
Travel Guides	1	0	0	0.5	0.5			1	1
<b>Total, Other On-The-Job (percent of total jobs)</b>	<b>2,869</b>					<b>167 (6%)</b>	<b>159 (6%)</b>	<b>620 (22%)</b>	<b>608 (21%)</b>
<b>Grand Total (percent of total jobs)</b>	<b>6,162</b>					<b>1,756 (28%)</b>	<b>1,589 (26%)</b>	<b>907 (15%)</b>	<b>745 (12%)</b>

Notes: 1. For Phase II of Truck scenarios we use 0.1\* full implementation job losses. 2. For combined AV scenarios (such as the "Trucking-Fast" Scenario combined with the Cars-Fleet scenario) the shared displaced are added together. Sources: Occupational employment. Bureau of Labor Statistics Occupational Employment Survey 2015. Share of jobs eliminated based on consultation with industry experts.

## Appendix B: Estimates of Affected Jobs in Primary Driving and Secondary Occupations in Oregon

Estimates of Oregon Jobs Affected by 2040s Under Various Household and Commercial Autonomous Vehicle Adoption Scenarios

SOC Code	Standard Occupational Classification Title	Household Scenarios		Commercial Scenarios	
		Cars Personal	Cars Fleet	Trucking Slow	Trucking Fast
53-3011	Ambulance Drivers and Attendants, Except Emergency Medical Technicians	4	4	4	4
53-3021	Bus Drivers, Transit and Intercity	0	0	1,800	1,928
53-3022	Bus Drivers, School or Special Client	0	0	3,649	3,649
53-3031	Driver/Sales Workers	1,530	1,530	0	0
53-3032	Truck Drivers, Heavy and Tractor-Trailer	0	0	16,193	17,542
53-3033	Truck Drivers, Light or Delivery Services	0	0	5,556	6,791
53-3041	Taxi Drivers and Chauffeurs	654	2,289	0	0
53-3099	Motor Vehicle Operators, All Other	122	122	0	0
13-1032	Insurance Appraisers, Auto Damage	n/a	n/a	n/a	n/a
33-1012	Supervisors and Managers of Police and Detectives	69	69	69	69
33-3051	Police and Sheriff's Patrol Officers	283	283	227	283
33-9032	Security Guards	229	229	229	229
39-7010	Tour and Travel Guides	46	46	0	0
43-5021	Couriers and Messengers	32	32	0	0
43-5052	Postal Service Mail Carriers	671	671	0	0
49-2096	Electronic Equipment Installers and Repairers, Motor Vehicles	30	30	0	0
49-3021	Automotive Body and Related Repairers	1,066	1,066	107	107
49-3022	Automotive Glass Installers and Repairers	72	72	0	0
49-3023	Automotive Service Technicians and Mechanics	3,927	3,927	785	785
53-6021	Parking Lot Attendants	382	382	0	0
53-6031	Service Station Attendants	2,589	3,884	0	0
53-7081	Refuse and Recyclable Material Collectors	0	0	1,185	1,185
		<b>11,706</b>	<b>14,636</b>	<b>29,804</b>	<b>32,572</b>

**Combined Household and Commercial Scenario**      **Jobs Affected\***

Personal cars + slow trucking	41,510	primary driving occupations
Fleet cars + slow trucking	44,440	secondary affected occupations
Personal cars + fast trucking	44,278	
Fleet cars + fast trucking	47,208	

Sources: *Preparing U.S. Workers and Employers for an Autonomous Vehicle Future*, Groshen et al., June 2018, and Oregon Employment Department

**Notes and Assumptions:**

**\*Affected does not always equal "lost." Some affected occupations may still exist, with notably different skills and responsibilities on the job.**

Affected occupations identified by U.S. Dept. of Commerce Office of Chief Economist; shares of affected jobs in occupations identified by Groshen et al. (p.36-37)

Per report (p.31-32): "In both the fleet and personal ownership light duty scenarios, most AV are initially shared, with initial deployment around 2020, and an

inflection point into rapid adoption around 2030. "Cars personal" means a scenario where most households own their own AV, "Cars fleet" means most

households use shared AV fleet owned by a company.

Per report (p.33-34): "Trucking slow" means Level 1/2 automation mainstream in 2020s, Level 3/4 automation mainstream in 2030s, and advanced Level 4/5

becoming available in 2040s. "Trucking fast" uses the same progression, and assumes roughly 10 years faster timeline, so Level 4/5 automation is nearly

completed in the 2040s.

## Appendix C: Shares of Workers Ages 55 and Older in AV-Affected Occupations

### Oregon Workers Ages 55 and Older in Autonomous Vehicle-Affected Occupations, 2013-2017

	55 or Older	All Workers	% Ages 55 and Older
<b>All Workers</b>	<b>416,750</b>	<b>1,886,042</b>	<b>22%</b>
All AV-affected occupations	25,568	93,390	27%
Primary driving occupations	17,721	51,141	35%
Other on-the-road driving-related occupations	7,847	42,249	19%

Source: U.S. Census Bureau, American Community Survey, using IPUMS USA, <https://usa.ipums.org>

### U.S. Workers Ages 55 and Older in Autonomous Vehicle-Affected Occupations, 2018

	55 or Older	All Workers	% Ages 55 and Older
<b>All Workers</b>	<b>36,270,000</b>	<b>155,761,000</b>	<b>23%</b>
All AV-affected occupations	2,283,000	8,239,000	28%
Primary driving occupations	1,589,000	5,000,000	32%
Other on-the-road driving-related occupations	694,000	3,239,000	21%

Source: Current Population Survey

# Recommendations for an Independent Study to Examine and Prepare for Potential Impacts of Automated Vehicles on the Workforce

## Introduction

In the first report submitted to the Legislature in 2018, the Task Force on Autonomous Vehicles recommended that an independent workforce study be conducted. In preparation for the second report to be submitted in September 2019, the task force has discussed elements to be included in such a study. The task force recommendations are below.

## Recommendations

The Task Force on Autonomous Vehicles recommends that the Legislature commission and provide funding for an independent study to examine the potential impacts of automated vehicles on the workforce in Oregon. The independent study has two goals: a comprehensive quantitative analysis of how the deployment of automated vehicles could impact the workforce in Oregon, and suggestions for policy interventions to address those impacts.

### **The task force recommends that the quantitative analysis include but not be limited to:**

- Impacts of driver-assistance technologies (SAE Levels 1-2), where a human driver will still be required in the vehicle.
- Impacts of highly and fully automated vehicles (SAE Levels 3-5), where intervention by a human driver in the vehicle may not be necessary.
- Identification of occupations that are likely to be affected by the deployment of automated vehicles, including occupations that are likely to see job losses, as well as occupations that are likely to see job growth.
- Information on the required skills and wages of occupations that are likely to be affected by automated vehicles and occupations that will remain after the deployment of automated vehicles.
- Projections for the required skills and wages of new occupations created by the deployment of automated vehicles.
- Lessons learned from other industries that have gone through comparable transitions, including data on job-to-job flows.

The task force also recognizes that the deployment of automated vehicles may impact not only jobs that primarily involve driving, but could also have an impact on adjacent industries such as the retail industry, the auto repair industry, and the insurance industry. The task force recommends including the affected occupations identified in Gail Krumenauer's report, "Occupations Affected by Autonomous Vehicle Adoption in Oregon." The decision to include or not include adjacent industries should depend on the scope of the study.

### **The task force recommends that the policy interventions identified in the study include but not be limited to:**

- Strategies for mitigating worker displacement, including mitigation strategies for workers for whom retraining would not be a good fit.
- Strategies to prepare the incoming workforce for new jobs created by the automated vehicle industry.
- Strategies to ensure that jobs created by the deployment of automated vehicles are high-quality family-wage jobs.
- Lessons learned from other industries that have gone through comparable transitions, including effective and ineffective policy interventions.

**The task force recommends engaging with stakeholders to inform the independent study:**

The task force recognizes that that this list is not comprehensive and that more work is necessary to fully scope the independent study. The task force recommends consulting with stakeholders, including labor unions, business and industry, and relevant public agencies, to inform the scope and research for the independent study.

## Studies and References

### Introduction

This document is a compilation of the studies and references used or discussed in the Subcommittee on Workforce Changes. It also includes some relevant documents collected by ODOT staff and subcommittee members. This list is supposed to help policymakers carry out further research and to demonstrate some of the grounding for the task force’s work products.

### Studies and References:

**America’s Workforce and the Self-Driving Future**

Securing America’s Future Energy (SAFE)

<https://avworkforce.secureenergy.org/>

**Automated Trucking: Federal Agencies Should Take Additional Steps to Prepare for Potential Workforce Effects**

United States Government Accountability Office (GAO-19-161).

<https://www.gao.gov/assets/700/697353.pdf>

**Automation and Workforce Listening Session**

U.S. Department of Transportation

<https://www.transportation.gov/av/workforce>

**Driverless? Autonomous Trucks and the Future of the American Trucker**

UC Berkeley Center for Labor Research and Education and Working Partnerships USA

Guide for Laid Off Workers in Oregon

**Oregon Office of Community Colleges and Workforce Development**

<https://www.oregon.gov/highered/institutions-programs/workforce/Documents/Dislocated/Guide%20for%20Laid%20Off%20Workers%20in%20Oregon.docx>

**Scope of the Study on the Impact of Automated Vehicle Technologies on Workforce**

U.S. Department of Transportation

<https://www.regulations.gov/docket?D=DOT-OST-2018-0150>

# CONCLUSION

With this report, the Task Force on Autonomous Vehicle is providing the Legislature with information about how automated vehicles could potentially impact a wide array of policy areas. The task force also intends for this report to recommend next steps Oregon could take to prepare for automated vehicle deployment. The wide-ranging membership of the task force has resulted in a set of materials and recommendations that reflects a range of perspectives from across Oregon and across many different industries.

With materials and recommendations on land use, road and infrastructure design, public transit, workforce changes, and state responsibilities relating to cybersecurity and privacy, this report fulfills the requirements laid out by House Bill 4063 (2018) for the 2019 report. However, automated vehicle technology is still in development and recommended best practices could change. As the technology advances, Oregon will need an ongoing process to monitor these changes to maximize the benefits of automated vehicles for all Oregonians and people traveling within our borders.

# APPENDICES

Appendix A: House Bill 4063 (2018)

Appendix B: Task Force Members' Official Comment Letters

Appendix C: Public Comments

**APPENDIX A:**  
HOUSE BILL 4063 (2018)

**Enrolled**  
**House Bill 4063**

Introduced and printed pursuant to House Rule 12.00. Pre-session filed (at the request of House Interim Committee on Transportation Policy)

CHAPTER .....

AN ACT

Relating to autonomous vehicles; and declaring an emergency.

**Be It Enacted by the People of the State of Oregon:**

**SECTION 1.** The Department of Transportation is the lead agency responsible for coordination of autonomous vehicle programs and policies.

**SECTION 2.** (1) The Task Force on Autonomous Vehicles is established.

(2) The task force consists of 31 members appointed as follows:

(a) The President of the Senate shall appoint two members from among members of the Senate who are not members of the same party.

(b) The Speaker of the House of Representatives shall appoint two members from among members of the House of Representatives who are not members of the same party.

(c) The Director of Transportation shall appoint 27 members as follows:

(A) Six members representing state agencies that will be affected by the deployment of autonomous vehicles.

(B) Twenty-one members as follows:

- (i) One representative of the automotive industry;
- (ii) One representative of the cybersecurity industry;
- (iii) One representative of law enforcement;
- (iv) One representative of transportation network companies;
- (v) One representative of the autonomous vehicle technology industry;
- (vi) One representative of the automotive insurance industry;
- (vii) One representative of trial lawyers;
- (viii) One representative of workers' unions;
- (ix) Two representatives of transportation unions;
- (x) One representative of the Association of Oregon Counties;
- (xi) One representative of the League of Oregon Cities;
- (xii) One representative of the American Automobile Association;
- (xiii) One representative of the Oregon Trucking Associations;
- (xiv) One representative of the taxicab industry;
- (xv) One representative of a metropolitan planning organization;
- (xvi) One representative of the Oregon Transit Association;
- (xvii) One representative of a nonprofit entity;
- (xviii) One representative of the commercial truck manufacturing industry;
- (xix) One representative of consumer protection advocates; and

(xx) One representative of a public university.

(3)(a) The task force shall develop recommendations for legislation to be introduced during the next odd-numbered year regular session of the Legislative Assembly regarding the deployment of autonomous vehicles on highways.

(b) The proposed legislation under this section shall be consistent with federal law and guidelines and shall address the following issues:

- (A) Licensing and registration;
- (B) Law enforcement and accident reporting;
- (C) Cybersecurity; and
- (D) Insurance and liability.

(4) The task force may study and consider the potential long-term effects of autonomous vehicle deployment to be addressed in future legislation, including the following:

- (a) Land use;
- (b) Road and infrastructure design;
- (c) Public transit;
- (d) Workforce changes; or
- (e) State responsibilities relating to cybersecurity and privacy.

(5) A majority of the voting members of the task force constitutes a quorum for the transaction of business.

(6) Official action by the task force requires the approval of a majority of the voting members of the task force.

(7) The task force shall elect one of its members to serve as chairperson.

(8) If there is a vacancy for any cause, the appointing authority shall make an appointment to become immediately effective.

(9) The task force shall meet at times and places specified by the call of the chairperson or of a majority of the voting members of the task force.

(10) The task force may adopt rules necessary for the operation of the task force.

(11)(a) The task force shall submit a report in the manner provided by ORS 192.245, and shall include recommendations for legislation described in subsection (3) of this section, to the appropriate interim committee of the Legislative Assembly related to transportation no later than September 15, 2018.

(b) The task force may submit a report in the manner provided by ORS 192.245, and may include recommendations for legislation, if any, resulting from the task force's study under subsection (4) of this section, to the appropriate interim committee of the Legislative Assembly related to transportation no later than September 15, 2019.

(12) The Department of Transportation shall provide staff support to the task force.

(13) Members of the Legislative Assembly appointed to the task force are nonvoting members of the task force and may act in an advisory capacity only.

(14) Members of the task force who are not members of the Legislative Assembly are not entitled to compensation or reimbursement for expenses and serve as volunteers on the task force.

(15) All agencies of state government, as defined in ORS 174.111, are directed to assist the task force in the performance of the task force's duties and, to the extent permitted by laws relating to confidentiality, to furnish information and advice the members of the task force consider necessary to perform their duties.

**SECTION 3.** Section 2 of this 2018 Act is repealed on January 2, 2021.

**SECTION 4.** This 2018 Act being necessary for the immediate preservation of the public peace, health and safety, an emergency is declared to exist, and this 2018 Act takes effect on its passage.

**Passed by House March 1, 2018**

.....  
Timothy G. Sekerak, Chief Clerk of House

.....  
Tina Kotek, Speaker of House

**Passed by Senate March 2, 2018**

.....  
Peter Courtney, President of Senate

**Received by Governor:**

.....M.,....., 2018

**Approved:**

.....M.,....., 2018

.....  
Kate Brown, Governor

**Filed in Office of Secretary of State:**

.....M.,....., 2018

.....  
Dennis Richardson, Secretary of State

**APPENDIX B:**  
TASK FORCE MEMBERS' OFFICIAL  
COMMENT LETTERS

Oregon Task Force on Autonomous Vehicles  
ODOT  
355 Capitol Street NE, MS 11  
Salem, OR 97301

September 4, 2019

**RE: Public Agency Data Needs**

Dear Task Force and Interested Parties:

As members of the Task Force on Autonomous Vehicles (AVs), we believe certain information about AVs should be shared with public agencies so those agencies can fulfill their responsibilities and comply with adopted laws, policies, and goals.

This is explored in the attached memo that the Task Force’s Land Use Subcommittee supported and proposed for inclusion in the Final Report. At its last meeting, the Task Force ran out of time to fully discuss this memo and vote on whether to include it as a full Task Force recommendation. We are submitting it here as public comment for inclusion in the report’s Appendix.

We recommend future work by the State and its partners thoughtfully consider the issues raised and recommendations made in the memo.

Thank you for your consideration.

Sincerely,

Evan Manvel,  
Department of Land Conservation and  
Development

Eliot Rose  
(Metro)  
Metropolitan planning organization

Chris Hagerbaumer  
(Oregon Environmental Council)  
Nonprofit organization

Jeremiah Ross  
(Ross Law LLC)  
Consumer protection advocates

Eric Hesse  
(City of Portland)  
League of Cities

Becky Steckler  
(University of Oregon)  
Public university

Jeff Owen  
(TriMet)  
Oregon Transit Association



# TASK FORCE ON AUTONOMOUS VEHICLES

*Framing the Future for Autonomous Vehicles in Oregon*

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To: Land Use Subcommittee Members of the Oregon Autonomous Vehicles Task Force  
From: Eric Hesse, League of Oregon Cities' Task Force Representative  
Date: April 18, 2019  
RE: Public Sector Information Needs to Guide AV Policy and Manage AV Testing/Deployment

## Background

As Oregon defines its policy and legal framework for the testing and deployment of Autonomous Vehicles (AVs), state, regional and local governments will require certain information to effectively fulfill their roles in implementing and advancing adopted policy goals and enforcing existing and developing new laws to protect and advance the public interest. As managers of the public realm, including the public rights of way in which AVs will operate, public sector entities are rightly aiming to define policies and practices to ensure AVs will improve traffic safety, decrease congestion, boost transportation choices, and support a strong economy and vibrant community development. To enable effective short- and long-term land use and transportation planning as well as ongoing transportation system management, the private sector—using public roads—should be required to share useful information to assist in that effort.

Transportation agencies have always collected information on how people and vehicles travel to make sure that the transportation system and is safe and efficient for all users, and that companies that provide transportation services operate responsibly. Our infrastructure is built with public funds, and the public expects us to use data to oversee it responsibly. This memo aims to outline what information will be most useful in this regard and suggest ways in which it can be provided to ensure efficacy for the purposes above while duly protecting personal privacy and proprietary competitive information.

## Why do public sector agencies need information about AVs?

To carry out their responsibility to plan and manage transportation and land use systems AVs, along with other recent developments in technology, both require us to improve the information that we use due to the significant impacts they will have on how people travel, and that they present an opportunity to do so because they collect large amounts of data. In order to fulfill State, Metropolitan Planning Organization (MPO) and local governmental responsibilities for federal and state transportation and land use planning requirements, we need better information to carry out our responsibilities for two key reasons:

- **The transportation system is changing more rapidly than ever before, so we need more up-to-date information.** Most transportation modelling is based primarily on the Household Travel Survey, which is part of the census. These surveys are so labor-intensive and costly, we only are able to update them every decade. Up until recently, this system worked fine because the way in which people traveled did not change that much from year to year, but that is no longer the case. The Portland Metro region's last travel survey was completed in 2010. Uber and Lyft began serving our metro area in 2015, and in 2018 they carried over 12 million trips in the City of Portland alone—and we have no way of accounting for these services in our transportation demand models used for planning and compliance purposes. Some

agencies, including Metro and the City of Portland, are exploring private data sources that promise to capture AVs and shared mobility, but these sources are expensive and are not always reliable. AVs will likely accelerate the pace of disruption, because there are dozens of companies poised to launch an Uber- or Lyft-like service when AVs arrive. We can't keep up with the pace of change unless we update the information we gather more frequently.

- **Vehicles aren't sticking to highways, so we need more geographically detailed information.** Up until recently, when traffic was bad most drivers used to stay on the main road because they didn't know a better route. Consequently, most transportation agencies placed the sensors that they use to conduct traffic counts on main roads. Now, GPS systems and apps like Waze help drivers find opportunities to shave a few minutes off their commutes by taking shortcuts down neighborhood streets to avoid congested areas; AVs will automate this process. In order to manage congestion and ensure that local roads are safe, it will no longer be sufficient for local governments to focus on freeways and major arterials; we will need information on how vehicles are using most streets. We need more detailed information on travel patterns, collisions and near-misses to better design the transportation system to keep everyone moving and prevent traffic deaths.

## Agencies need information to address the unique opportunities and challenges presented by AVs

There are a host of unique issues that AVs present, and we need information on how they are traveling to take advantage of new opportunities and tackle new challenges:

- **Many AVs will likely be operated in shared fleets by private companies.** The first passenger AVs are expected to be deployed as shared vehicles by companies like GM, Waymo, Uber and Lyft, and some believe that AVs will usher in an era when far fewer people own cars. On one hand, this could allow us to convert parking lots into places for people and could make travel more convenient for everyone. On the other hand, it would fall to public agencies to ensure that profit-motivated companies provide safe and equitable service and create regulations or incentives to encourage them to help reduce congestion.
- **Local governments will also likely need to consider new methods of collecting transportation revenue.** As revenue from gas tax, vehicle registration fees, and parking fees decline significantly, mileage charges may be the most efficient and fair way to replace the gas tax. Many cities have enacted regulations on Uber and Lyft to ensure that they provide safe and equitable service, and some even collect fees from these services that they use to fund public transportation or wheelchair-accessible service. Local governments need to continue to have the right to regulate these services and collecting information on how these services operate is key to understanding their impact on the public roads, verifying the accuracy of payments, and developing and administering effective regulations that maximize the full potential of AVs.
- **Dedicating lanes for AVs could make the system more efficient for everyone.** AVs are expected to move more people per lane because they can travel in high-speed platoons—but this won't happen at scale if they are mixed with human-operated vehicles. We need to know how many AVs are using a roadway so that we can identify the point when it makes sense to dedicate roadway space to AVs to help them realize their potential while protecting public safety.

agencies, including Metro and the City of Portland, are exploring private data sources that promise to capture AVs and shared mobility, but these sources are expensive and are not always reliable. AVs will likely accelerate the pace of disruption, because there are dozens of companies poised to launch an Uber- or Lyft-like service when AVs arrive. We can't keep up with the pace of change unless we update the information we gather more frequently.

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- **AVs can circle instead of parking, increasing congestion and emissions.** If parking is too costly or inconveniently located, travelers could direct their vehicles to circle the block or travel to a faraway lot instead of parking, adding to traffic and pollution. We need information on how AVs behave with no passenger in the car so that we can manage traffic and parking—and we won't get that information from surveying people on their travel behavior.

It is important to note that many of these information needs stem from interests that agencies and the public share with the companies that are advancing AV technology. We all want to reduce congestion and keep the transportation system in good shape so that everyone can get where they need to go, whether they are in an AV, a human-driven vehicle, or a bus. We all want to maximize the potential of AVs to make our streets safer and more efficient and our communities more vibrant. We are aligned with companies like Daimler, GM, Waymo, Uber and Lyft in wanting people to be able to share vehicles and trips. We understand companies' concerns about protecting confidential and competitive information, and we are already addressing these concerns and set the stage for collaboration in meeting our shared goals.

### What information do state and local governments need to fulfill their responsibilities?

Information most relevant to understanding the impacts of AVs on travel and maximizing their benefits are listed below. The list is consistent with the National Association of City Transportation Officials' (NACTO) 2017 [Data Sharing Principles](#).<sup>1</sup>

- **Trip origins, destinations, types (passenger, goods delivery, or zero-occupancy/goods), and time of day,** to understand travel demand. NACTO calls for origin/destination data at the block face level (i.e., which side of a city block a trip or ends at). Cities such as Portland, [New York](#) and [Boston](#) collect TNC data at the block face level or an even finer scale.
- **The number of vehicle occupants,** allowing Oregon to incentivize shared travel and capture value from zero-occupant vehicles. Cities have become more interested in occupancy data as the impacts of TNCs on congestion have become more apparent ([New York](#) and [San Francisco](#)).
- **Location and severity of collisions and location of instances of rapid acceleration and deceleration and sudden collision avoidance.** [As Oregon's vision is to eliminate deaths and serious injuries on its transportation system by 2035](#), maximizing the safety benefits of AVs is a key opportunity to reach that goal. Transportation agencies use state and federal collision information to identify safety problems. Yet data on non-fatal collisions is not always available, and collisions are often under-reported. AVs can provide that information, including data on near-misses to help identify potentially dangerous locations before collisions occur. Most TNC regulations require collision reporting (for example, see [Portland's City Code, section 16.40.280](#)), and NACTO calls for collecting data on collisions and acceleration/deceleration.
- **Route traces and parking information** to understand how AVs are affecting travel patterns (e.g., whether vehicles cruise or park, whether AVs are rerouting onto local streets to avoid congestion and

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<sup>1</sup> NACTO is preparing to release a policy paper on "Managing Mobility Data" in May 2019. This policy paper will build upon the referenced Data Sharing Principles and may be useful to this discussion.

how they may be contributing to congestion based on time and location). This is the only data point listed that is not reflected in NACTO's principles nor in existing TNC regulations, but we believe it is critical to fully understanding the impacts of AVs. For public agencies, collecting this data would create the risk of compromising personal information since detailed information on trip patterns could be used to identify individuals, and it would also pose technical issues associated with storing and managing large quantities of data. Potential ways to address these issues are discussed below.

- **Traffic volumes and length of trips (in minutes) and/or vehicle speeds** to identify congested trips and causes of delay.
- **Information on traffic violations by AVs.** While hopefully a small set of data, it would be helpful to understand if there are any underlying challenges of safely integrating law-constrained AVs into the transportation system with human-driven vehicles, bicycles and pedestrians. Information about AVs violating local traffic laws, speed limits, traffic signals, etc., would be useful.

Additional information from Transportation Network Companies (TNCs) operating AVs would be helpful to help ensure shared fleets provide safe and equitable service.

- **Service provider (e.g., Uber, Lyft) and type (e.g., UberBLACK, UberPOOL).** This is a standard requirement in city-TNC data sharing agreements. Cities are increasingly interested in service type since the introduction of shared TNC services, but few collect it.
- **Booking type (advance/real-time); wait time; cost of trip; and location, date, and time of unfulfilled, declined, and cancelled rides.** This information helps ensure shared fleets are meeting people's needs throughout our communities. Shared fleets [might be able](#) to provide travel options for those who need them the most. The evidence is mixed. Some studies of TNCs have found [people of color](#), [people in wheelchairs](#), and other marginalized groups face longer wait times and greater numbers of unfulfilled rider requests. Overlaying data on wait times, costs, and cancellations with Census demographic data can help us understand whether Oregonians are receiving equitable service.
- **Number and type of passenger complaints** can be a valuable resource for understanding safety and equity. Portland collects TNC complaint data (see pp 19-20 of the [Greyball Audit Report](#)).

## How should information be provided?

Data must be properly managed to avoid compromising privacy and proprietary information, yet public agencies already manage a variety of sensitive data, including data on people's health and employment, while protecting privacy. Aggregation is the most common method to protect sensitive data, and one of the simplest to execute. Aggregation can enable agencies to readily use data to fulfill its responsibilities. Data can be aggregated spatially, temporally, or both. Other techniques such as truncation and synthesis can also help yield actionable information while protecting individual privacy.

Public agencies are not interested in individual trips per se; agencies are interested in travel patterns. That said, many transportation agencies may lack the technical capabilities and financial resources to manage large quantities of data. These agencies may need to rely on third parties to aggregate and manage geolocation data on their behalf. Third party data aggregation and management could be done through contracts with for-profit

companies; public- or private-universities; other cities, regional or county governments; transit agencies; and/or, state transportation agencies. The decision about whether a specific entity should aggregate and manage AV data likely depends on a variety of factors, such as, but not limited to, its technical capabilities; financial resources; cybersecurity measures; data retention requirements; any allowed secondary uses of the data; any allowed sale, disclosure, transfer, and assignment of the data to other affiliated and non-affiliated organizations; and, its privacy protections, including the ability to exempt sensitive data from public release.

At this point, it is difficult to recommend a one-size fits all approach to aggregating AV data. Needs vary by agency type (local agencies need finer-scale data than regional or state agencies) and type of data (we typically need more detailed data on safety than we do on travel patterns because we need to pinpoint collision “hot spots”). The level of data aggregation is also driven by the amount of data available. When less data points are available, data is aggregated at a larger scale in order to avoid revealing personal information or drawing conclusions based on samples that are not statistically significant. Eventually, AVs will likely carry enough trips that it will be possible to aggregate data at a very fine scale without compromising private/personal data or the validity of results, and the recommendations we offer below are based on this assumption. However, it may be necessary to rely on more aggregate data during the coming transition when AVs account for fewer overall trips. NACTO’s 2017 [Data Sharing Principles](#) recommend aggregating different data to different scales, and our recommendations below, which are largely consistent with NACTO’s recommendations, follow suit.

<b>Data type</b>	<b>Spatial aggregation</b>	<b>Temporal aggregation</b>
Trip origins and destinations	Block face	Hourly averages
Number of occupants	Street segment	Hourly averages
Safety (collisions, sudden acceleration/ deceleration)	Point (disaggregate)	Real-time
Route traces	Street segment or by origin/destination pairs, or disaggregate with trip ends truncated	Hourly averages
Traffic volumes and speeds	Street segment	Hourly averages
Booking type; wait time; cost of trip; unfulfilled, declined/cancelled rides	Census tract	Hourly averages
Passenger complaints	N/A (complaint data does not need to be spatial)	Real-time

Jaguar Land Rover North America  
Global Digital Design Portland Hub  
1450 NW 18 Ave  
Portland, OR 97209  
+1 971 256 9701



4 September 2019

Dear Sir or Madam:

I appreciate the opportunity to enter this commentary to the ODOT Autonomous Vehicle Task Force's (AVTF) 2019 report to the Oregon legislature. Advancing technologies that make public roads safer is a cornerstone of our business at JLRNA.

JLRNA, as a member of the Alliance of Automobile Manufacturers, recommends clear avenues for preempting state governments from having rules or requirements that are inconsistent with the federal role and responsibilities. It is the industry position that patchwork state laws create a scattered regulatory environment and only work to hamper development and deployment of this life-saving technology. As such, industry supports recommendations such as those from the Vehicle Codes Subcommittee to look to national bodies such as the International Society of Automotive Engineers for concepts when creating new terms and definitions related to Oregon statutes.

One ongoing concern is that for the size of the AVTF, there is an underrepresentation of industry experts with deep knowledge of this emerging technology. Industry response to any specific recommendation is formulated by giving AutoAlliance members ample time to review artifacts produced from subcommittee meetings. Unfortunately, with only one automotive representative, the appropriate legal experts are not always connected to respective subcommittee recommendations within the time allotted by AVTF staff. Because of this disconnect, my support of any recommendation may not guarantee industry support for a bill. In the future, consider exporting subcommittee reports directly to the AutoAlliance to provide timely feedback as recommendations are shaped.

Thank you for the opportunity to serve the state of Oregon. Specifically, I want to thank Representative Susan McLain for her presence and leadership throughout the AVTF process. JLRNA looks forward to making Oregon roads the safest in the country.

Sincerely,

A handwritten signature in dark ink, appearing to read "Daniel Fernández".

Daniel Fernández  
Senior Software Engineer  
Assisted & Automated Driving  
Jaguar Land Rover North America

# Comment Letter to Oregon Task Force on Autonomous Vehicles

September 4, 2019

## **Response to Impact area: Electric Vehicle Charging**

Thank you for the opportunity to respond to the Oregon Task Force on Autonomous Vehicles, *Framing the Future for Autonomous Vehicles in Oregon Road & Infrastructure Design Subcommittee's Impacts Assessment to Prepare for Future Transportation System*.

Oregon Environmental Council (OEC) is a member of the Task Force and in coordination with Forth, Oregon's foremost expert on transportation electrification, would like to directly respond to certain elements within the Subcommittee's *Impacts Assessment to Prepare for Future Transportation System Impact Area: Electric Vehicle Charging* report.

[OEC](#) is a nonprofit, nonpartisan, statewide organization that advances innovative, collaborative, and equitable solutions to Oregon's environmental challenges for today and future generations.

[Forth](#) is a nonprofit organization advancing electric, shared and smart transportation through innovation, demonstration, advocacy, and engagement. Forth (formerly Drive Oregon) was started and funded by the State of Oregon to promote transportation electrification.

Specifically, we would like to address the *Impact Area: Electric Vehicle Charging* portion of the report within the following areas.

### **Policy Factors Driving Electric Vehicle Adoption**

#### *State and Federal Subsidies*

The rollout of electric vehicles is aided and enabled by concurrent rollout of federal and state incentives and public charging infrastructure in public locations and at home.

According to the International Council on Clean Transportation (ICCT) report, *The Surge of Electric Vehicles in United States Cities*, consumer incentives remain vital to reduce electric vehicles' upfront costs. Nine of the 11 major metropolitan areas with the greatest uptake had consumer incentives typically worth \$2,000-5,000. As the federal \$7,500 electric vehicle tax credit begins to phase out for some manufacturers, continued state, city and utility incentives will remain very important. (1)

#### *Charging Infrastructure*

Home charging and charging at multiple unit dwellings (MUDs) provides most of the charging needed for most drivers, but public charging infrastructure increases driver confidence, extends range (when not at home or at a MUD), and increases visibility and public awareness of electric vehicles. Public charging increases the electric vehicle proposition for prospective buyers, increases the potential electric miles from electric vehicles, and provides charging for those without home charging.

According to the International Council on Clean Transportation (ICCT), substantial charging infrastructure investments are needed to fill the charging gap, with necessary investments in workplace, public level 2, and DC fast Charging infrastructure. Based on a recent charging gap analysis, 4 times more public charging infrastructure is need by 2025 to match expected electric vehicle market growth than was in place in 2017. Specifically, in the metro Portland region,

Portland needs 80% more charging infrastructure in order to meet the amount of charging infrastructure needed in 2025. (2)

With regard to the costs of installing EV charging: the costs for Level 1 non-networked, one or two chargers per pedestal from \$596-\$813; for Level 2 non-networked and networked for one or two chargers per pedestal ranges from \$938-\$3,127; and for DC fast chargers networked 50kW, 150kW, and 350kW ranges from \$28,401 to \$140,000. ICCT calculated these costs from the average hardware costs from several studies (2) and manufacturer price quotes. (3) (4)

### *Conclusion*

Electric vehicles surged into U.S. cities in 2018, supported by various government policy actions. These activities, including consumer financial incentives, charging infrastructure buildout, and other local policy promotions such as Oregon's Charge Ahead Rebate Program (5) explain why the market is growing more quickly in areas with these incentives than those without. In addition, these incentives are vital to ensure that low- and moderate-income families can afford to lease or purchase new or used electric vehicles. In fact, electrified transportation is a key part of a more equitable transportation future. EVs are cheaper to operate, reduce tailpipe emissions to zero, and reduce greenhouse gas emissions. We can help ensure equitable distribution of benefits by providing incentives for EV ownership to low- and moderate-income families, providing EV car sharing and e-bikes, and routing electrified buses through low-income communities (which often suffer the greatest burden of air pollution).

The regions with the most EV support are on average experiencing the greatest growth in EVs. These regions demonstrate that state and local policy tools are needed to overcome consumer barriers to electric vehicles adoption. As the ICCT Surge report states, even as most charging occurs at home, greater electric vehicle market shares are typically where there is greater availability of public regular, public fast and workplace charging infrastructure. (1)

Reducing consumer, business and government purchasing barriers with policy, incentives, infrastructure buildout and awareness campaigns will continue to be necessary in order to increase electric vehicle adoption, to achieve Governor Kate Brown's Executive Order No. 17-21 to accelerate zero emission vehicle adoption (6) (7), and to ensure we realize the climate, air quality and equity benefits of transportation electrification.

Sincerely,

Chris Hagerbaumer,  
Deputy Director of Programs & Administration, Oregon Environmental Council

Jeanette Shaw,  
Senior Director, Public Affairs and Policy, Forth

### REFERENCES

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- 2) Michael Nicholas, Dale Hall, and Nic Lutsey, *Quantifying the electric vehicle charging infrastructure gap across U.S. markets*, (ICCT: Washington DC, 2019), <https://www.theicct.org/publications/charging-gap-US> and [https://theicct.org/sites/default/files/publications/US\\_charging\\_Gap\\_20190124.pdf](https://theicct.org/sites/default/files/publications/US_charging_Gap_20190124.pdf)

- 3) Avista Utility, “Docket No. UE-160082 – Avista Utilities Semi-Annual Report on Electric Vehicle Supply Equipment Pilot Program” (2018), [https://www.utc.wa.gov/\\_layouts/15/CasesPublicWebsite/CaseItem.aspx?item=document&id=00044&year=2016&docketNumber=160082&resultSource=&page=&query=&refiners=&isModal=&omItem=false&doItem=false](https://www.utc.wa.gov/_layouts/15/CasesPublicWebsite/CaseItem.aspx?item=document&id=00044&year=2016&docketNumber=160082&resultSource=&page=&query=&refiners=&isModal=&omItem=false&doItem=false); Department of Energy, “Transportation Energy Futures Series, Alternative Fuel Infrastructure Expansion: Costs, Resources, Production Capacity and Retail Availability for Low-Carbon Scenarios” (2013), <https://www.osti.gov/biblio/1079728-transportation-energy-futures-series-alternative-fuel-infrastructure-expansion-costs-resources-production-capacity-retail-availability-low-carbon-scenarios>; Pierre Ducharme and Catherine Kargas. *Feasibility of a Pan-Canadian Network of DC Fast Charging Stations for EVs*, (Electric Vehicle Symposium 29: Montréal, Québec, Canada, June 19–22, 2016), <https://www.mdpi.com/2032-6653/8/1/1/pdf>; Josh Agenbroad, “Pulling back the veil on EV charging station costs,” Rocky Mountain Institute, accessed Jan 5, 2019, <https://rmi.org/pulling-back-veil-ev-charging-station-costs/>
- 4) “Commercial EVSE: Public, Fleet, Workplace Charging,” ClipperCreek, accessed February 1, 2019, <https://store.clippercreek.com/commercial/>; “Smart charging stations,” Chargepoint, accessed February, 1 2019, <https://www.chargepoint.com/products/commercial/>
- 5) Department of Environmental Quality, Comparing the Standard and Charge Ahead Rebates, <https://www.oregon.gov/deq/aq/programs/Pages/EV-Rebates.aspx>
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# JOINT COUNCIL OF TEAMSTERS NO. 37

Affiliated with the International Brotherhood of Teamsters

1872 NE 162<sup>nd</sup> Avenue  
Portland, Oregon 97230-5642

Telephone 503-251-2337



Fax 503-251-2303

Tony L. Andrews  
President

September 03, 2019

Oregon Department of Transportation  
355 Capitol Street NE  
Salem, OR 97301-3871

RE: AV Task Force Final Recommendations

Dear Chair Tannenbaum and members of the Task Force:

On behalf of the nine Local Teamster Unions in Oregon, we appreciate the opportunity to make comments regarding our concerns with the Task Force on Autonomous Vehicles 2019 Final Report.

As a member of the Task Force, I have participated in the development of these Final Recommendations and have voted to approve all of the recommendations with the exception of those coming from the Sub-Committee on Road and Infrastructure Design. The specific points we do not support appear within the final paragraph of the Parking/ Sub-Section: Co-benefits/advancing established goals **section which states: "This suggests that implementing parking reform today instead of waiting for AV's to enable parking reform tomorrow could help to steer AV's toward a shared-fleet model that would better support Oregon's policy goals."**

This is followed by the Sub-Section: Next Steps. Within the final paragraph is the statement: **"State, regional and local governments can also take action to manage and price the transportation system in a way that encourages people to share vehicles."** The final sentence in that section recommends, **"The State should also prioritize any AV funding or incentives for automated transit and shared AVs."**

Teamsters feel that this is an endorsement for the TNC network. Although the TNC network may play an important role in AV transportation in the future, we feel this endorsement is premature. Teamsters believe that before recommending the inclusion of TNCs in any solution, the Legislature should address issues regarding the misclassification of workers as Independent Contractors. We believe that the TNC operators abuse this classification.

Sincerely,

Mark MacPherson  
Joint Council of Teamsters No. 37

**APPENDIX C:**  
PUBLIC COMMENT



Internet Association



TECHNOLOGY  
ASSOCIATION  
OF OREGON



TECHNET  
THE VOICE OF THE  
INNOVATION ECONOMY

August 12, 2019

Dear Members of the AV Task Force:

On behalf of our members, representing a broad and diverse coalition of leading technology and industry companies, we write to urge the AV Task Force to set-aside the recent draft position papers regarding Cybersecurity Policy, Geolocation Data, and Data Privacy (Right to be Forgotten) released and reviewed at your July 22<sup>nd</sup> Subcommittee on Cybersecurity, Privacy and Data Subcommittee meeting.

The positions reflected in these draft position papers have broad sweeping implications far beyond transportation, and specifically the Autonomous Vehicle (AV) sector, that this Task Force is charged with addressing. In addition, we feel this conversation requires broader stakeholder engagement than that currently reflected in the Subcommittee on Cybersecurity, Privacy and Data and on the Task Force.

Accordingly, we believe these conversations are a better fit for the Attorney General's Privacy Workgroup that kicked off in June, which plans to tackle the broader privacy conversation over the next year-and-a-half. It is critically important for this state to not only have consistent data policy positions across all state agencies, but also that these policies reflect national and international best practices and regulations.

As you know, Attorney General Rosenblum has a track record of tackling the very complex and at times controversial issues surrounding the topic of privacy and innovation. She has convened a diverse group of stakeholders on both sides of the table with issue experts committed and engaged in having an Oregon-specific conversation. We strongly believe it is imperative to establish baseline policy on these broad topics prior to making recommendations in the transportation sector.

Please work with the AG's Privacy Workgroup to find a new, better forum for these conversations in lieu of the AV Task Force making any policy recommendations on these important areas.

Respectfully,

CompTIA  
Internet Association

TechNet  
Technology Association of Oregon



Internet Association



TECHNOLOGY ASSOCIATION OF OREGON



TECHNET THE VOICE OF THE INNOVATION ECONOMY

August 20, 2019

Dear Members of the Oregon AV Task Force:

On behalf of our members and clients, representing a broad and diverse coalition of leading technology and industry companies, we write to express concerns regarding the League of Oregon Cities Memo Regarding Public Sector Information Needs to Guide AV Policy and Manage AV Testing/Deployment.

It is our understanding that the Memo was first discussed last week in the Land Use Subcommittee and submitted for review to the Cybersecurity & Privacy Subcommittee on Wednesday. The Privacy Subcommittee chose not to take a position on the memo, largely citing timing concerns. Our members have significant concerns with the limited time and consideration given to this broad sweeping policy memo and urge the Full Task Force to reject its inclusion in the Task Force Report due to lack of consideration and feedback.

Our members and clients believe a robust discussion on AV Testing and Deployment is welcome and we want to be fully engaged with the Task Force and their deliberations. However, it is difficult for stakeholders to provide meaningful input when recommendations are provided with very little notice.

Substantively, the memo lays out many transportation related issues, such as taxes, traffic congestion and infrastructure but none of the issues directly relates to cybersecurity or privacy, while the memo makes sweeping privacy policy statements. While the memo lays out several data points it believes would be helpful in managing transportation flow, it is silent on the existing infrastructure available to local governments (such as traffic cameras).

We ask the Task Force to table the League of Oregon Cities Memo Regarding "Public Sector Information Needs to Guide AV Policy and Manage AV Testing/Deployment" until there is an opportunity for full discussion on its merits or submit this letter for further consideration at the AG's Privacy Work Group.

Respectfully,

CompTIA

Internet Association

TechNet

Technology Association of Oregon



**TECHNET**  
THE VOICE OF THE  
INNOVATION ECONOMY

September 11, 2019

Members of the Oregon Task Force on Autonomous Vehicles:

*TechNet is the national network of over eighty technology companies that promotes the growth of the innovation economy through bipartisan advocacy at the federal and state level in all fifty states. TechNet's diverse membership includes dynamic American businesses ranging from small startups to the most prominent global companies and represents more than three million employees in the fields of information technology, e-commerce, clean energy, gig and sharing economy, venture capital, and finance.*

TechNet and its members support policies that encourage the safe deployment of fully autonomous vehicles (AVs) on public roads in the United States. TechNet greatly appreciates the thoughtful and good faith work of the OR AV Task Force, however, TechNet remains opposed to testing only legislation and encourages the adoption of legislation with a clear pathway to deployment of autonomous vehicles and the benefits that come with it.

The development of autonomous vehicles will enable tremendous societal benefits by improving vehicle safety and access to transportation for disabled people, the elderly, and others who cannot currently drive themselves. Fully autonomous vehicles have the potential to improve safety by reducing the severity and frequency of automobile accidents and to mitigate other inefficiencies of current motor vehicle use, such as congestion.

Without a pathway to deployment, there is no incentive for companies to test in the state. Therefore, the likelihood that any meaningful testing occurs in Oregon in the next few years would be very low. To limit Oregon to testing permits significantly sets the state back behind California and other states. Twelve states have already expressly authorized driverless commercial deployment through legislation, and two more have done so through Executive Orders.

Thank you in advance for your consideration on this matter. TechNet looks forward to continuing to engage on this issue.

Respectfully,

TechNet



11 September 2019

Dear Sir or Madam:

This letter is entered to supersede JLRNA's previous submission in Appendix B dated 4 September 2019.

I appreciate the opportunity to enter this letter to the ODOT Autonomous Vehicle Task Force (AVTF) 2019 report to the Oregon legislature. Through our Destination Zero Initiative of Zero Emissions, Zero Accidents and Zero Congestion, advancing technologies that make public roads safer is a cornerstone of our business at JLRNA.

JLRNA, as a member of the Alliance of Automobile Manufacturers (Alliance), recommends clear avenues for state governments having rules or requirements that are consistent with the federal role and responsibilities. It is the industry position that a patchwork of state laws creates a scattered regulatory environment and only work to hamper development and deployment of potentially life-saving autonomous technology. For example, we support the Vehicle Code Amendments Subcommittee recommendation to look to national bodies such as the International Society of Automotive Engineers for concepts when creating new terms and definitions related to Oregon statutes.

One ongoing concern is that for the size of the AVTF, there is an underrepresentation of industry experts with deep knowledge of this emerging technology. Industry response to any specific recommendation should be formulated by giving all Alliance members ample time to review artifacts produced from subcommittee meetings. Unfortunately, with only one automotive representative, the appropriate experts are not always available to respond to respective subcommittee recommendations within the time allotted by AVTF staff. Because of this disconnect, JLRNA support of any recommendation cannot guarantee industry support for any related bill. In the future, we would recommend assigning other Alliance member companies to each subcommittee or allow ample time for the Alliance to provide feedback on any recommendation.

Thank you for the opportunity to submit this comment. Specifically, I want to thank Representative Susan McLain for her presence and leadership throughout the AVTF process. We at JLRNA look forward to further collaboration in making Oregon roads the safest in the country.

Sincerely,

Daniel Fernández  
Senior Software Engineer  
Assisted & Automated Driving  
Global Digital Design Portland Hub  
Jaguar Land Rover



September 10, 2019

Oregon Task Force on Autonomous Vehicles  
Oregon Department of Transportation  
355 Capitol Street NE  
Salem, OR 97301

Dear Chair Tannenbaum and Members of the Task Force,

On behalf of the Safe Routes Partnership in the Pacific Northwest, I would like to thank the Oregon AV Task Force and ODOT for the opportunity to provide comment on the draft 2019 Report to the Oregon Legislature. I represent the Safe Routes Partnership, working in Oregon via the Pacific Northwest Regional Network; we are a national non-profit that works to advance safe walking and bicycling to and from schools, to improve the health and wellbeing of kids of all races, income levels, and abilities, and to foster the creation of healthy communities for everyone.

Since the formation of the Oregon AV Task Force last year, we have attended public meetings, submitted testimony, and followed resulting legislative activity, with careful attention to public safety and equity issues. We acknowledge the potential for positive change that AVs offer, including more cost-effective mobility options, freed up space for people walking and biking, and even reduced traffic-related injuries and fatalities. But we also recognize the significant downsides depending on how AVs are designed, tested and deployed, such as design flaws that increase risk, liability issues, and transportation options becoming too costly for people who are low-income or inaccessible for people with disabilities.

These are issues we've periodically raised with the Task Force, and we've also shared concerns that the Task Force membership, as specified by the Oregon Legislature, does not adequately represent the interest of people walking and rolling. Although this issue wasn't resolved, we are appreciative to the Road and Infrastructure Design Subcommittee, the Land Use Subcommittee, and to ODOT staff for holding a special joint meeting in June, which allowed for a more robust discussion on safety and equity concerns for vulnerable road users. We participated on a panel of four, to provide some context and policy recommendations for the Task Force's consideration, and we are encouraged to see many of these reflected throughout the draft 2019 Report, particularly in the impact assessments for road markings, school zones and curb space management.

We believe that with thoughtful policies, regulation, and safety standards, the promise of AVs could be realized by people of all abilities and income levels, and create more transportation options for Oregon communities. We'll keep following the Task Force's activity and any forthcoming legislation, to continue advocating for an elevated focus on public safety and social equity.

Sincerely,

Becky Gilliam  
Pacific Northwest Regional Policy Manager  
Safe Routes Partnership  
[becky@saferoutespartnership.org](mailto:becky@saferoutespartnership.org)

1 Safe Routes to School National Partnership | Pacific Northwest Regional Network  
[www.saferoutespartnership.org/pacific-northwest](http://www.saferoutespartnership.org/pacific-northwest)

September 11, 2019

Hello,

Please include my below comment in the report appendix.

Thank you for researching and discussing the potential positive and negative impacts of autonomous vehicles on cyclists and pedestrians. While the rerouting of autonomous vehicles to avoid congestion was discussed in the report, I am concerned that this discussion did not include the impact of the rerouting on cyclists and pedestrians. Since the new route may cause unsafe conditions for cyclists and pedestrians, I want this to be reviewed further by the Task Force on Autonomous Vehicles.

Sincerely,

Ray Atkinson  
Oregon City Resident  
[gismap1@gmail.com](mailto:gismap1@gmail.com)

September 9, 2019

We have a 2012 Nissan Leaf and are waiting to replace it with an electric car that has updateable autodrive features. We are in our 70's and see that in the near future our personal transportation may not be as safe unless it has autodrive.

We are looking forward to the time we can get in our car, press a button and our car will drive us to our preselected destination of, for example, our Kaiser Permanente doctor. That is the autodrive technology goal we are anticipating.

Ron and Joanna Stout  
3350 Azalea Dr S  
Salem, Oregon 97302